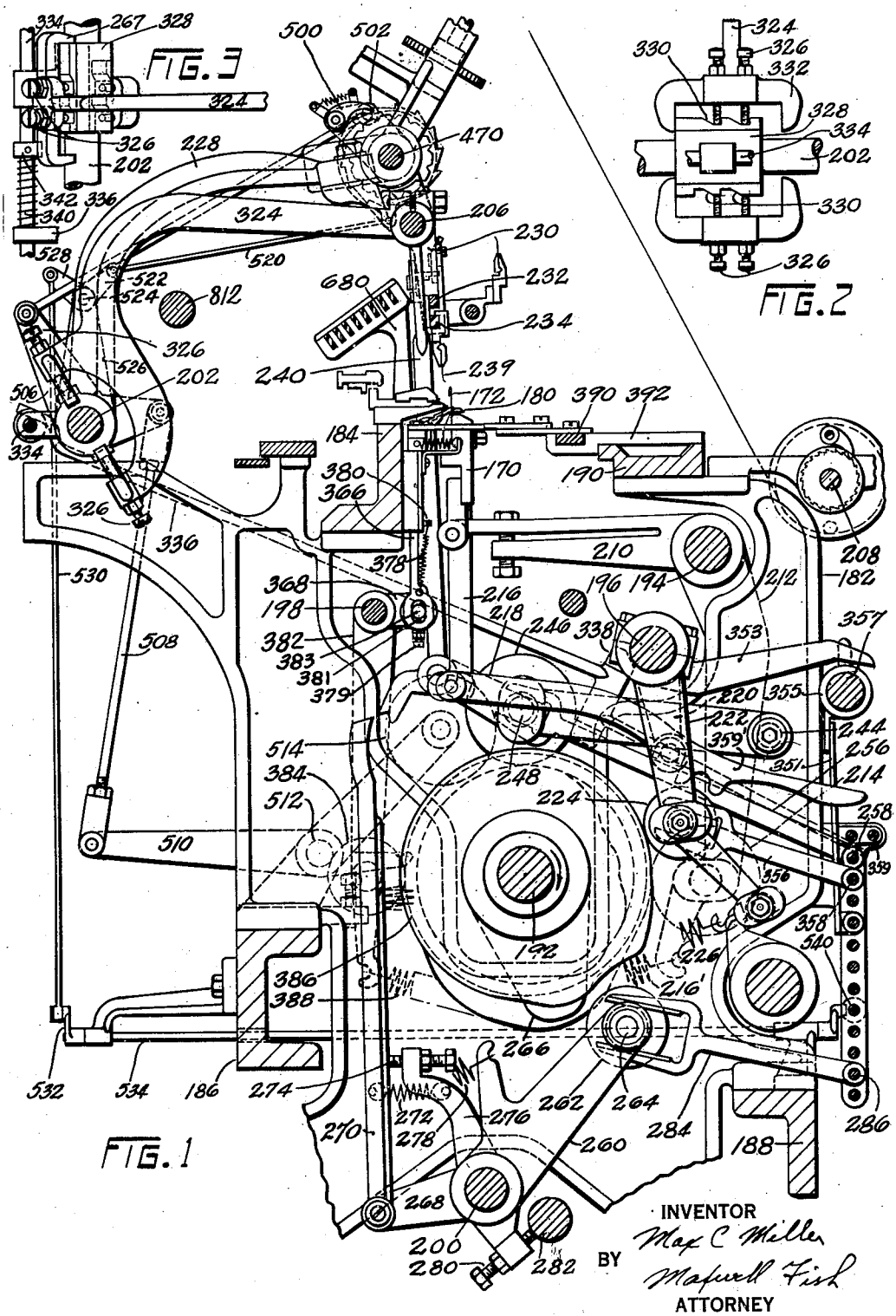
Nov. 29, 1949 M. C. MILLER 2,489,658

MANUFACTURE OF KNITTED HOSIERY

Filed July 9, 1945 18 Sheets-Sheet 1

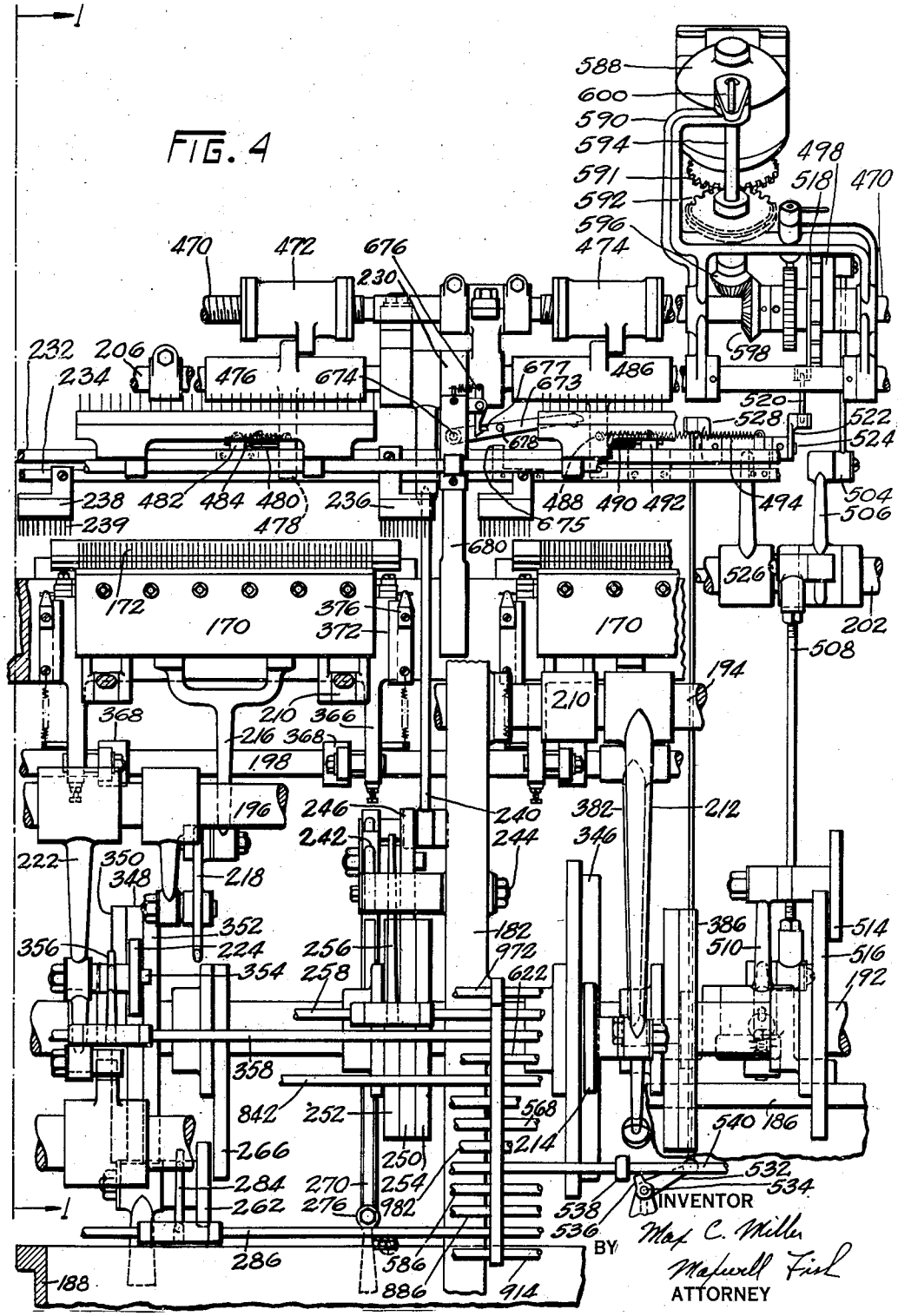


Nov. 29, 1949 M. C. MILLER 2,489,658

MANUFACTURE OF KNITTED HOSIERY

Filed July 9, 1945 18 Sheets-Sheet 2

FIG. 4



Nov. 29, 1949 M. C. MILLER 2,489,658

MANUFACTURE OF KNITTED HOSIERY

Filed July 9, 1945 18 Sheets-Sheet 3

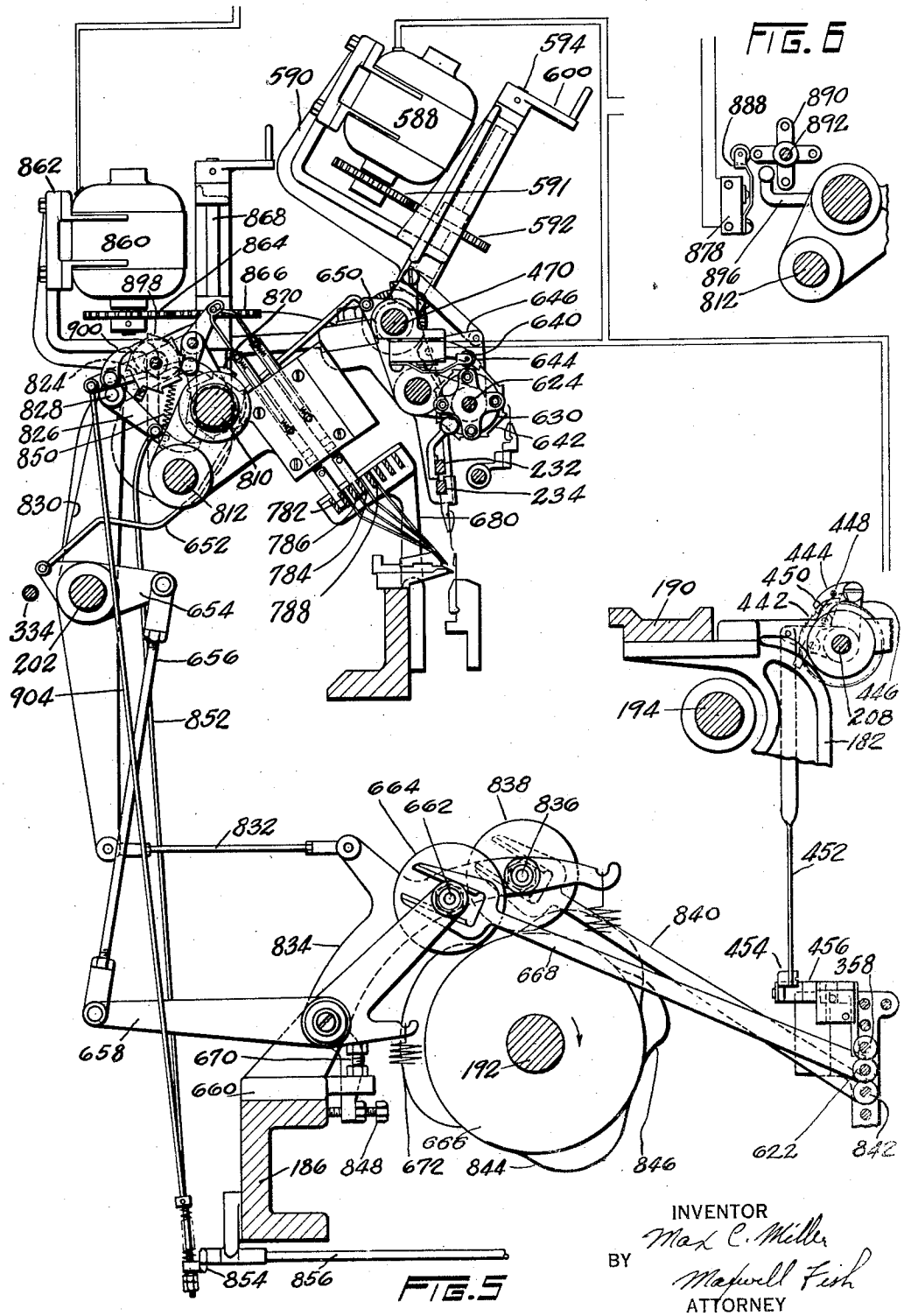


FIG. 6

FIG. 5

INVENTOR
Max C. Miller
BY
Maxwell Fish
ATTORNEY

Nov. 29, 1949 M. C. MILLER 2,489,658

MANUFACTURE OF KNITTED HOSIERY

Filed July 9, 1945 18 Sheets-Sheet 4

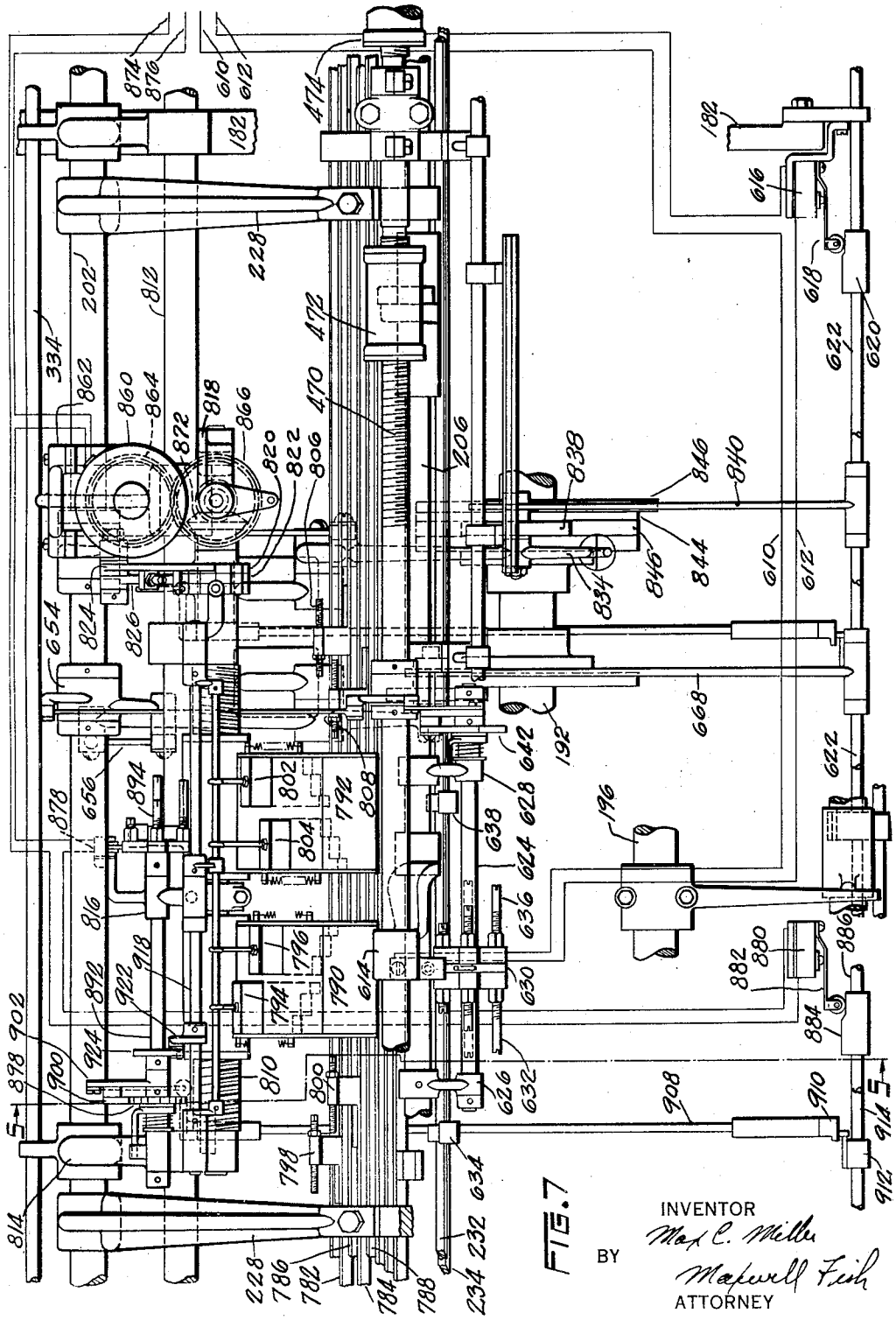


FIG. 7

INVENTOR
Max C. Miller
BY Maxwell Fish
ATTORNEY

Nov. 29, 1949 M. C. MILLER 2,489,658

MANUFACTURE OF KNITTED HOSIERY

Filed July 9, 1945 18 Sheets-Sheet 5

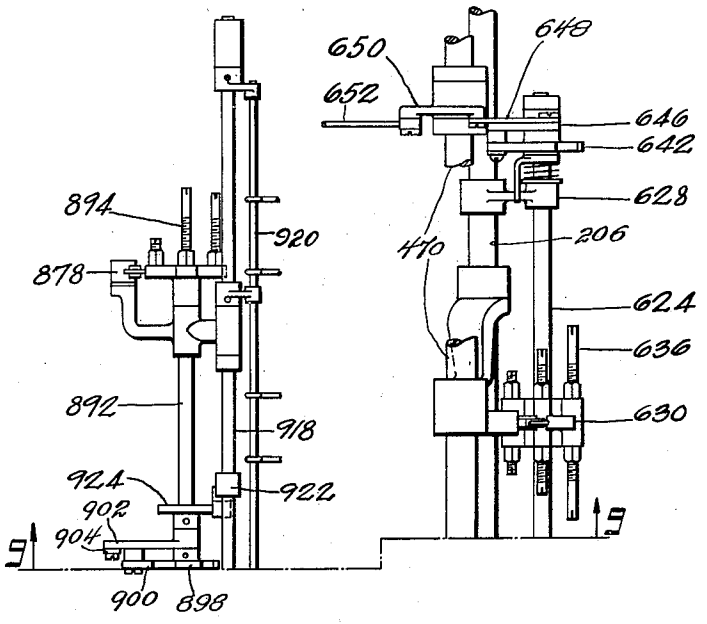


FIG. 8

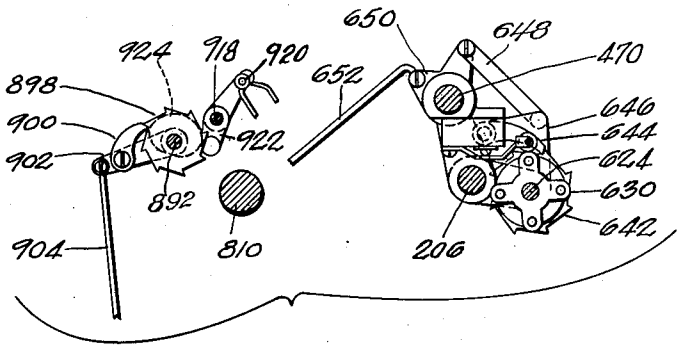


FIG. 9

INVENTOR.
Max C. Miller
BY
Marshall Fish
ATTORNEY

Nov. 29, 1949 M. C. MILLER 2,489,658

MANUFACTURE OF KNITTED HOSIERY

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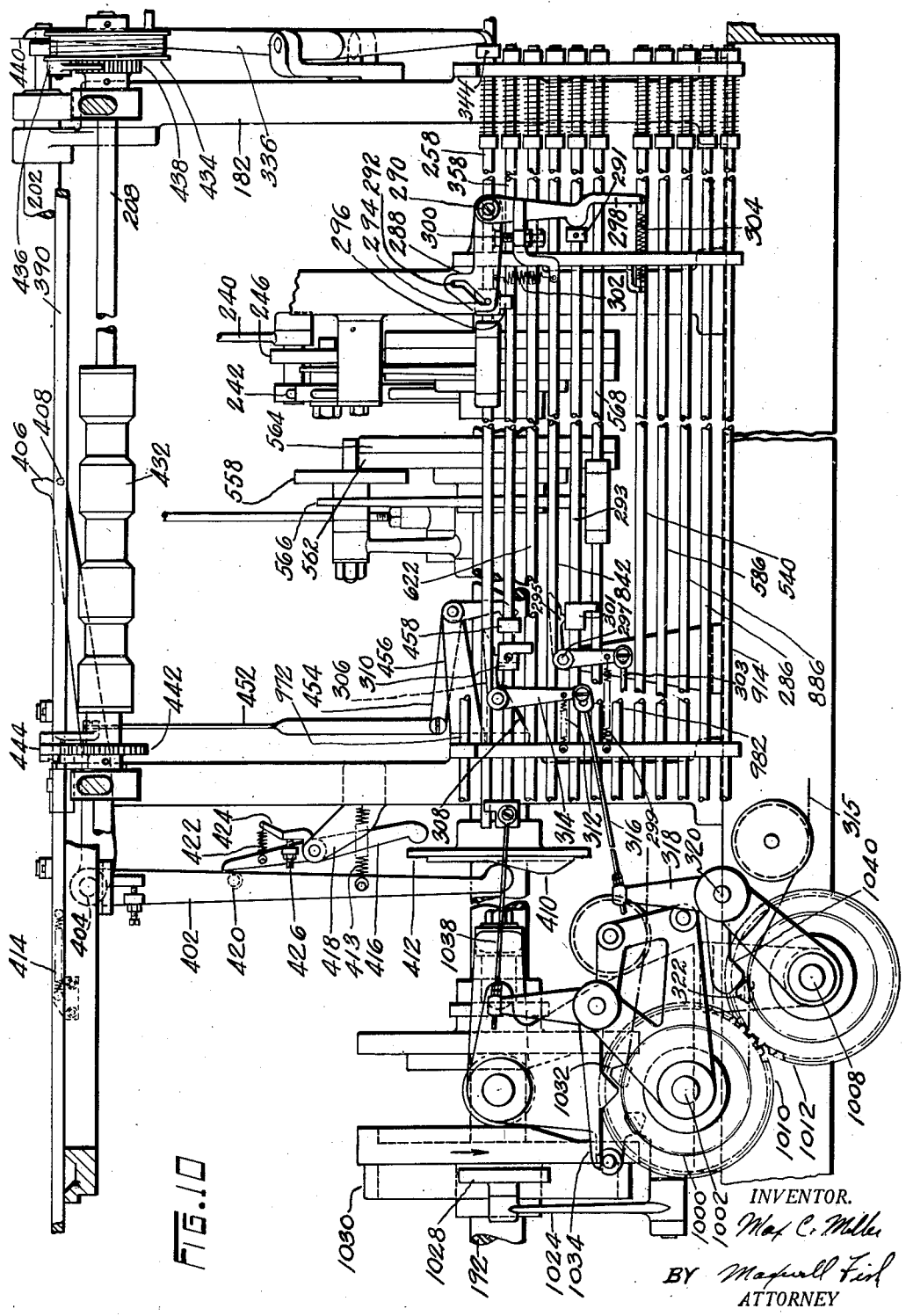


FIG. 10

INVENTOR.
Mat C. Miller
BY Maxwell Field
ATTORNEY

Nov. 29, 1949 M. C. MILLER 2,489,658

MANUFACTURE OF KNITTED HOSIERY

Filed July 9, 1945 18 Sheets-Sheet 7

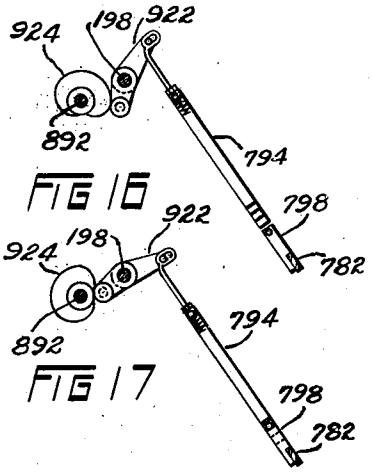


FIG 16

FIG 17

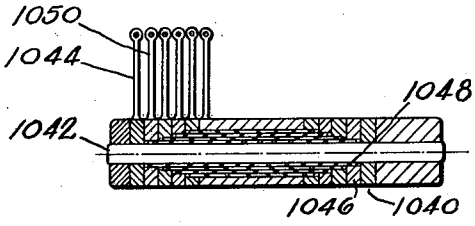


FIG. 13

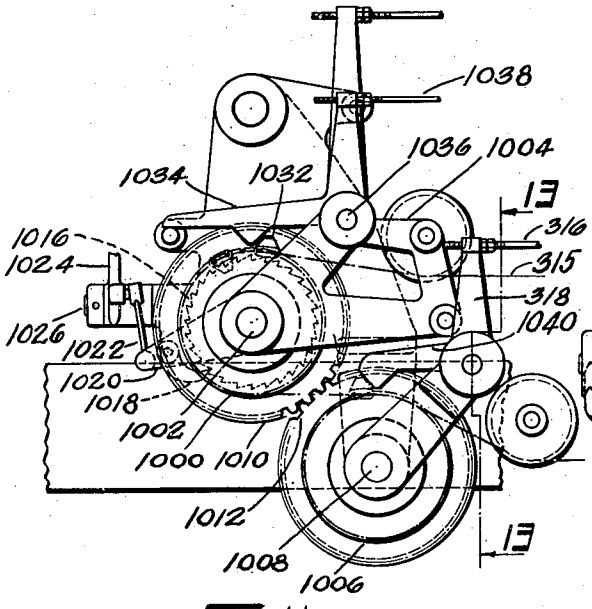


FIG. 11

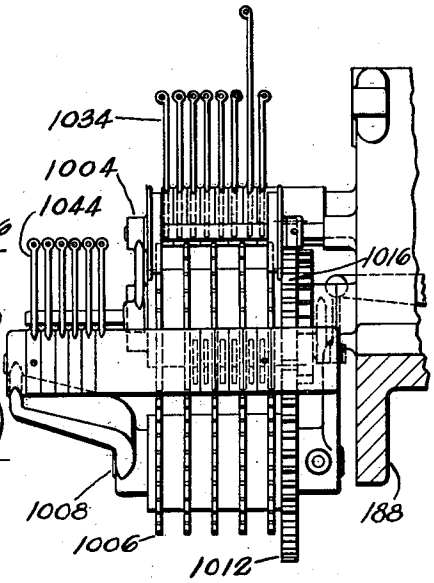


FIG. 12

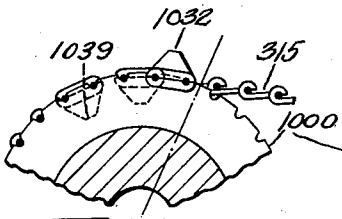


FIG. 14

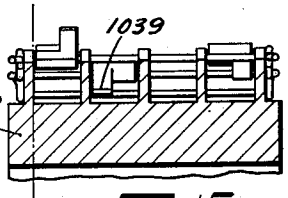


FIG. 15

INVENTOR
Max C. Miller
BY
Maxwell Fink
ATTORNEY

Nov. 29, 1949 M. C. MILLER 2,489,658

MANUFACTURE OF KNITTED HOSIERY

Filed July 9, 1945 18 Sheets-Sheet 8

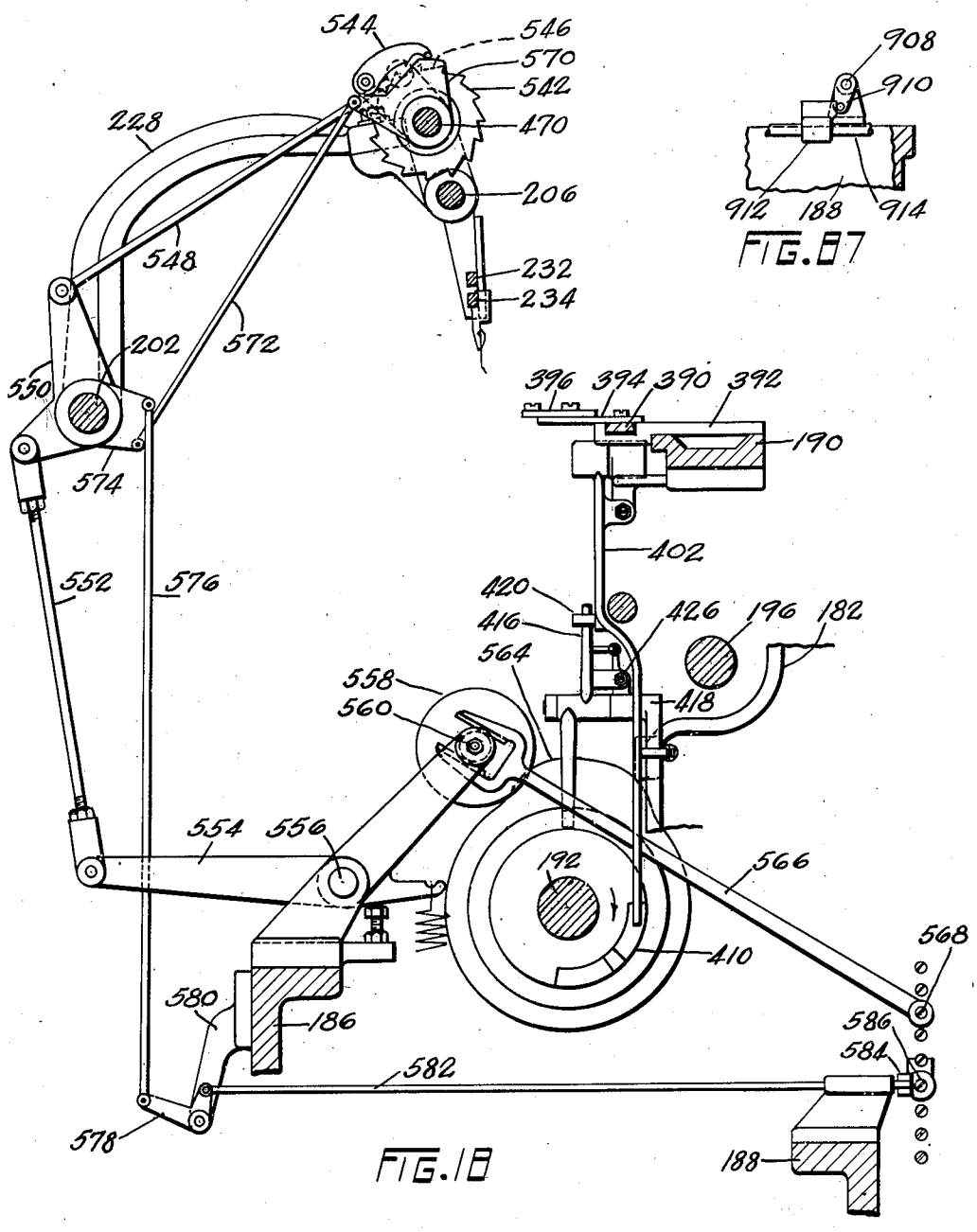


FIG. 18

FIG. 87

INVENTOR.
Max C. Miller
BY
Maxwell Fish
ATTORNEY

Nov. 29, 1949 M. C. MILLER 2,489,658

MANUFACTURE OF KNITTED HOSIERY

Filed July 9, 1945 18 Sheets-Sheet 9

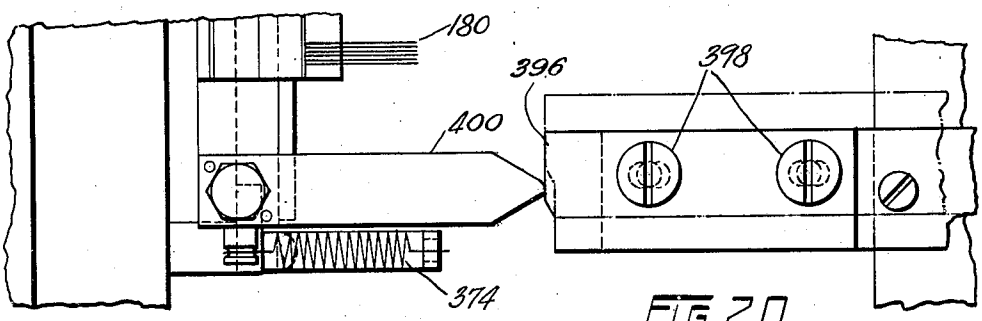


FIG. 20

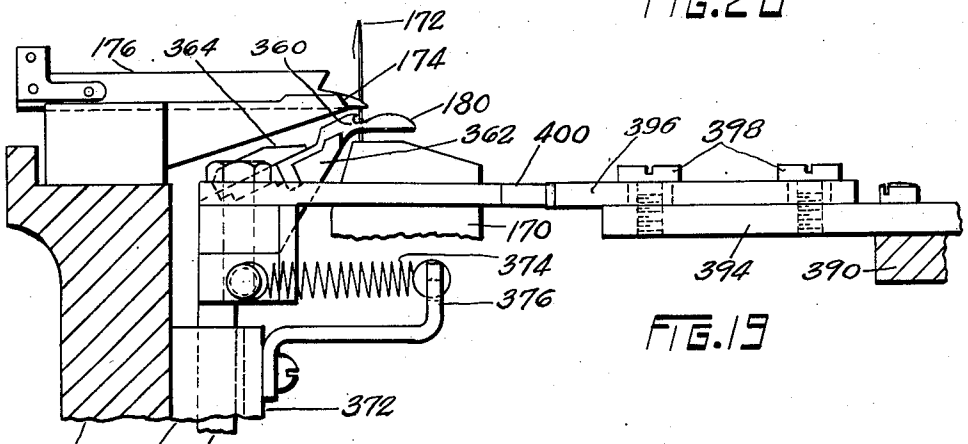


FIG. 19

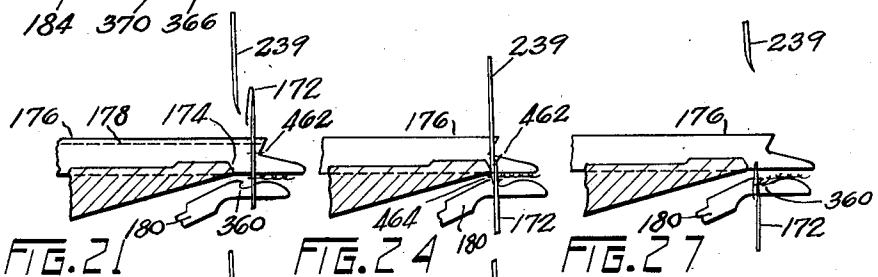


FIG. 21

FIG. 24

FIG. 27

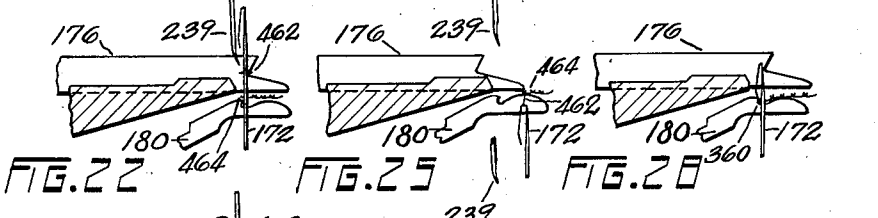


FIG. 22

FIG. 25

FIG. 28

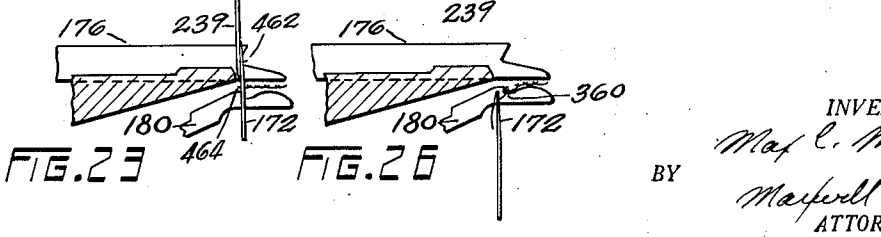


FIG. 23

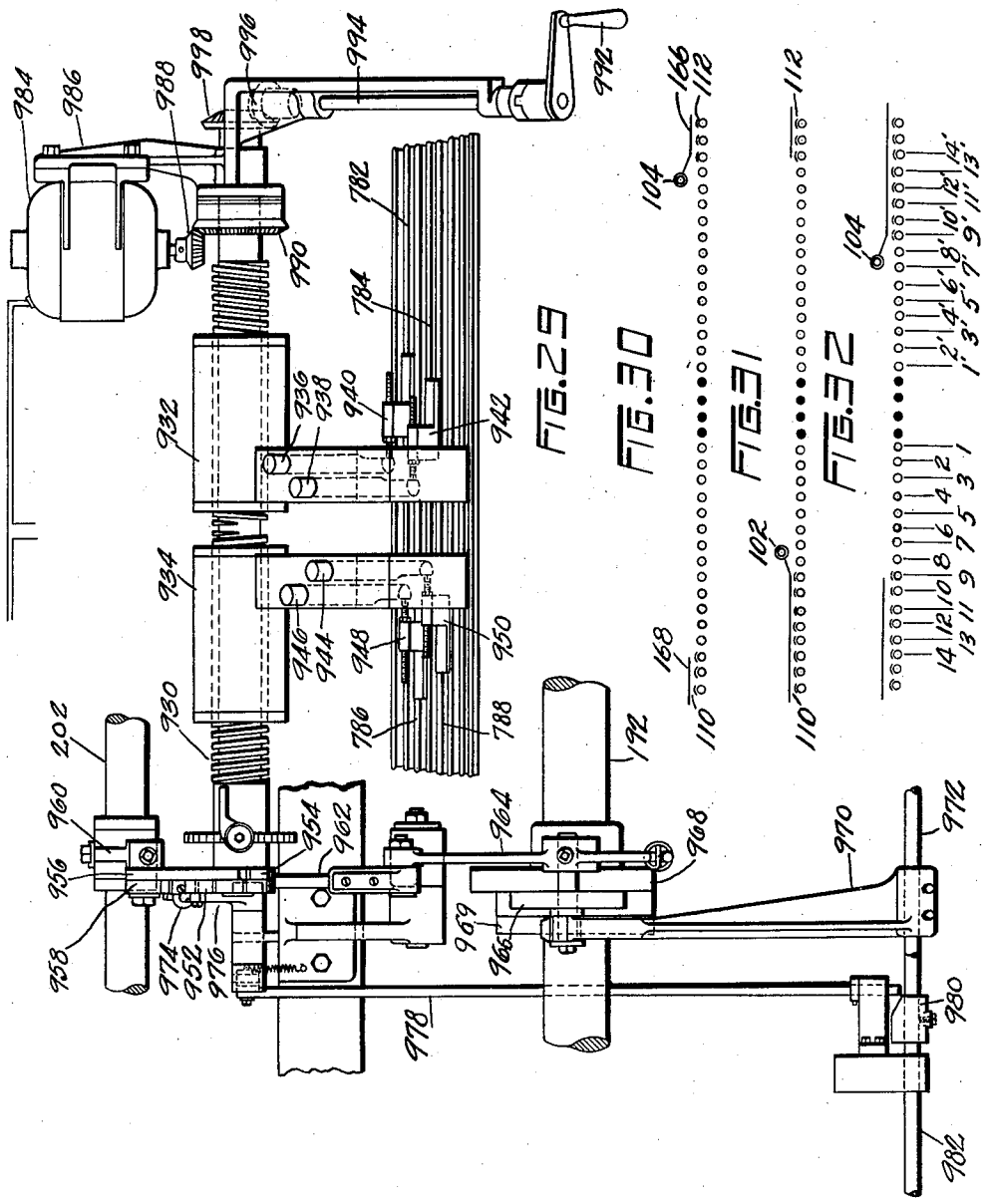
FIG. 26

INVENTOR.
Max C. Miller
BY
Maxfield Fish,
ATTORNEY

Nov. 29, 1949 M. C. MILLER 2,489,658

MANUFACTURE OF KNITTED HOSIERY

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INVENTOR.
Max C. Miller
BY
Maxwell Fish
ATTORNEY

Nov. 29, 1949 M. C. MILLER 2,489,658

MANUFACTURE OF KNITTED HOSIERY

Filed July 9, 1945 18 Sheets-Sheet 11

FIG. 33

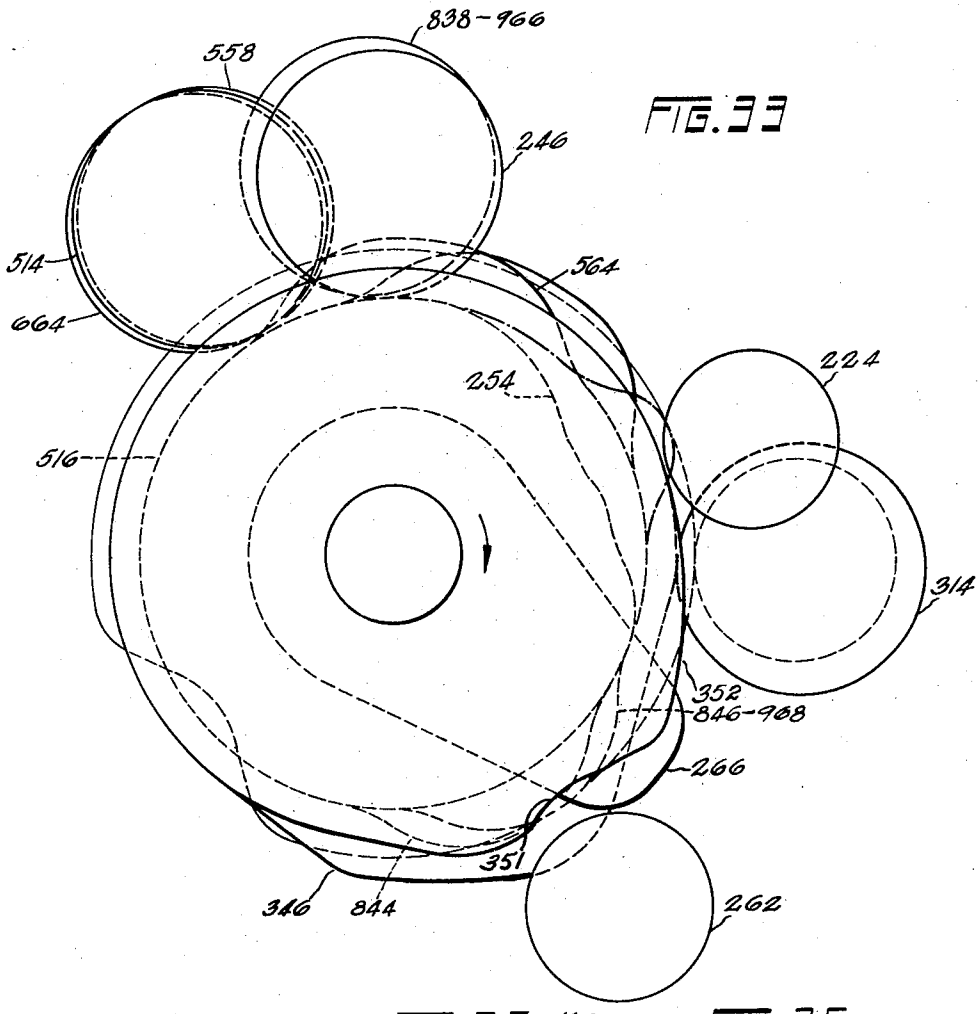


FIG. 34

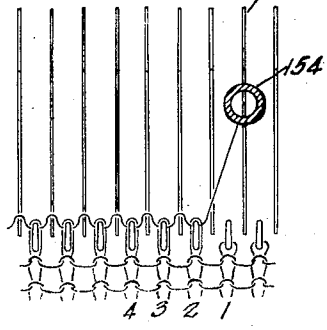


FIG. 35

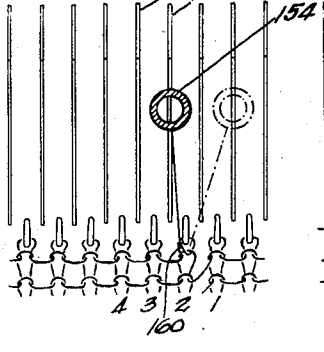
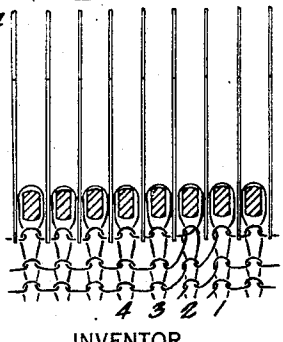


FIG. 36



INVENTOR
Max C. Miller
BY
Maxwell Finl
ATTORNEY

Nov. 29, 1949 M. C. MILLER 2,489,658

MANUFACTURE OF KNITTED HOSIERY

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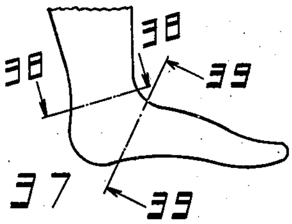


FIG. 37



FIG. 38

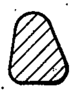


FIG. 39

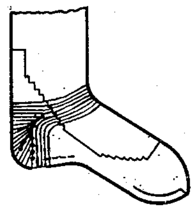


FIG. 40

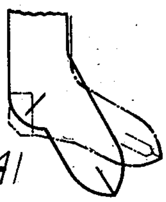


FIG. 41

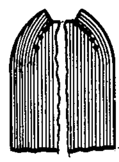


FIG. 42



FIG. 43



FIG. 44

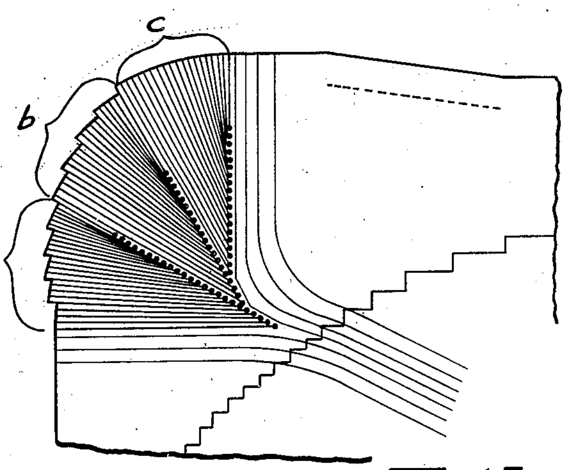


FIG. 45

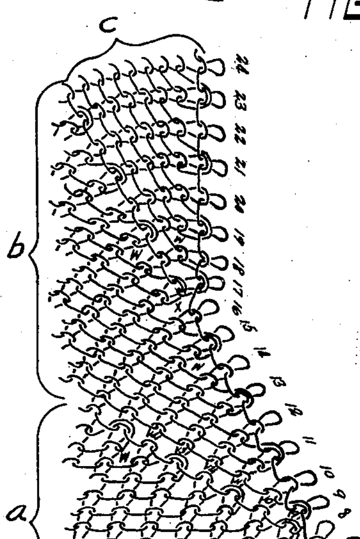
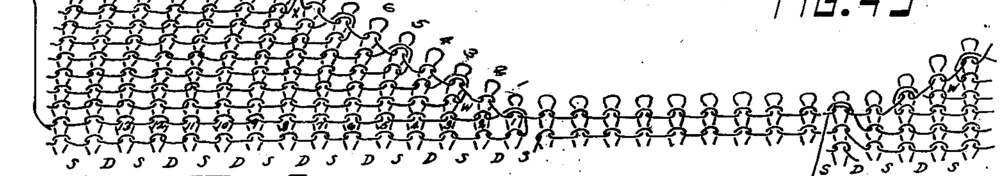



FIG. 46

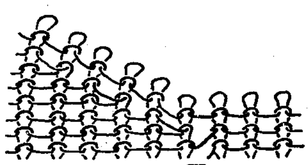


FIG. 47

INVENTOR

Max C. Miller

BY Maxwell Fish

ATTORNEY

Nov. 29, 1949 M. C. MILLER 2,489,658

MANUFACTURE OF KNITTED HOSIERY

Filed July 9, 1945 18 Sheets-Sheet 13

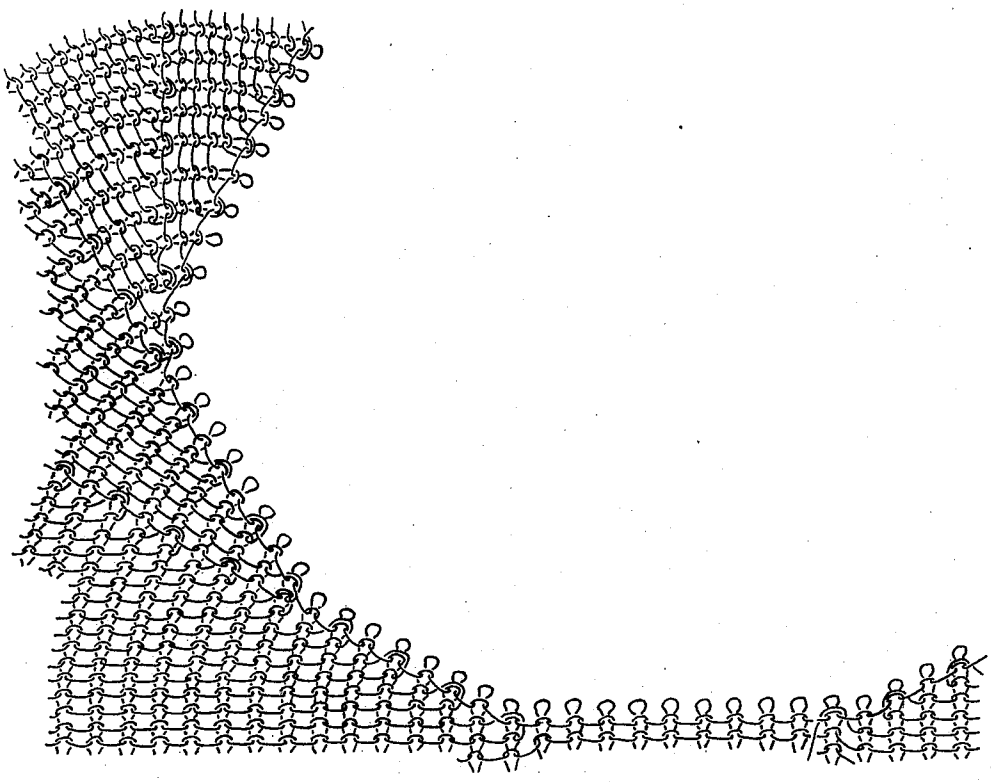


FIG. 48

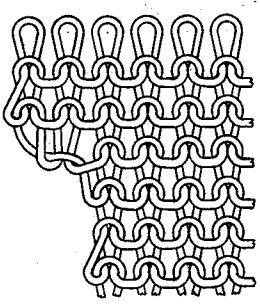


FIG. 49

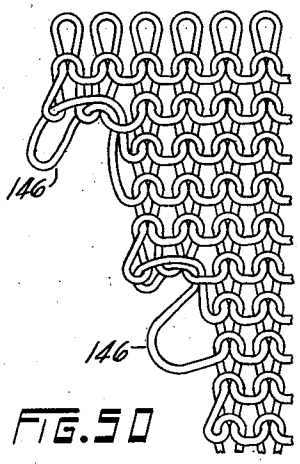


FIG. 50

INVENTOR.
Max C. Miller
BY
Maxwell Fish
ATTORNEY

Nov. 29, 1949 M. C. MILLER 2,489,658

MANUFACTURE OF KNITTED HOSIERY

Filed July 9, 1945 18 Sheets-Sheet 14

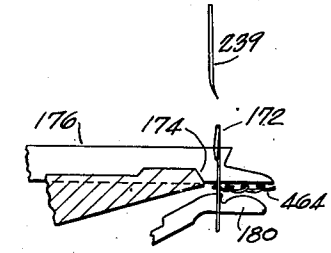


FIG. 52

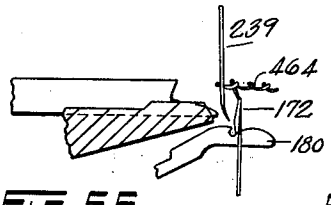


FIG. 56

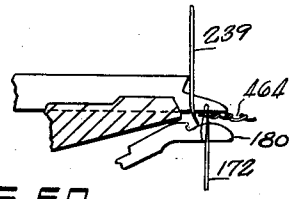


FIG. 60

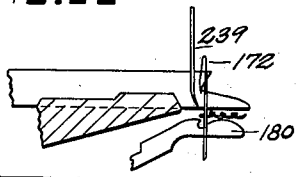


FIG. 53

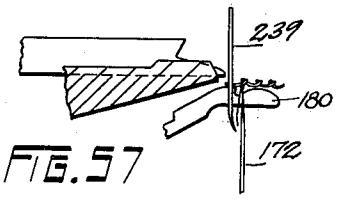


FIG. 57

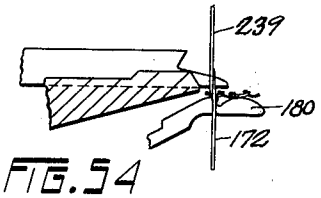


FIG. 54

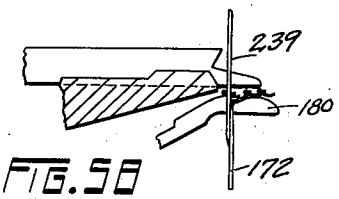


FIG. 58

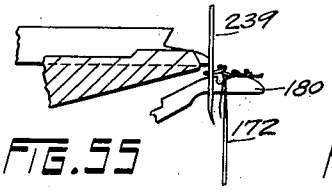


FIG. 55

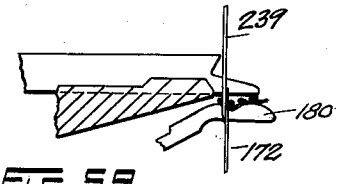
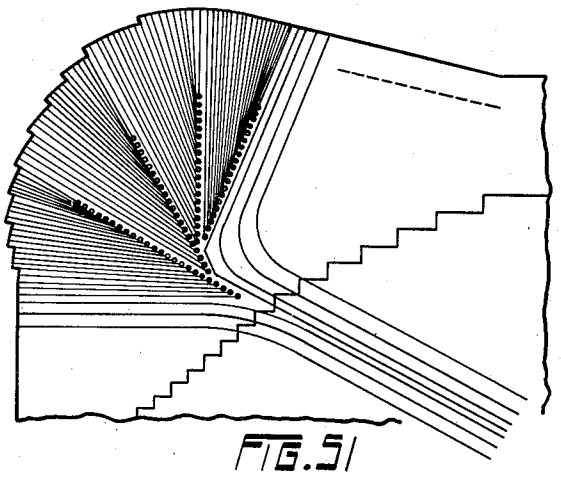


FIG. 59


FIG. 51

BY

INVENTOR.
Max C. Miller
Maxwell Fink
ATTORNEY

Nov. 29, 1949 M. C. MILLER 2,489,658

MANUFACTURE OF KNITTED HOSIERY

Filed July 9, 1945 18 Sheets-Sheet 15

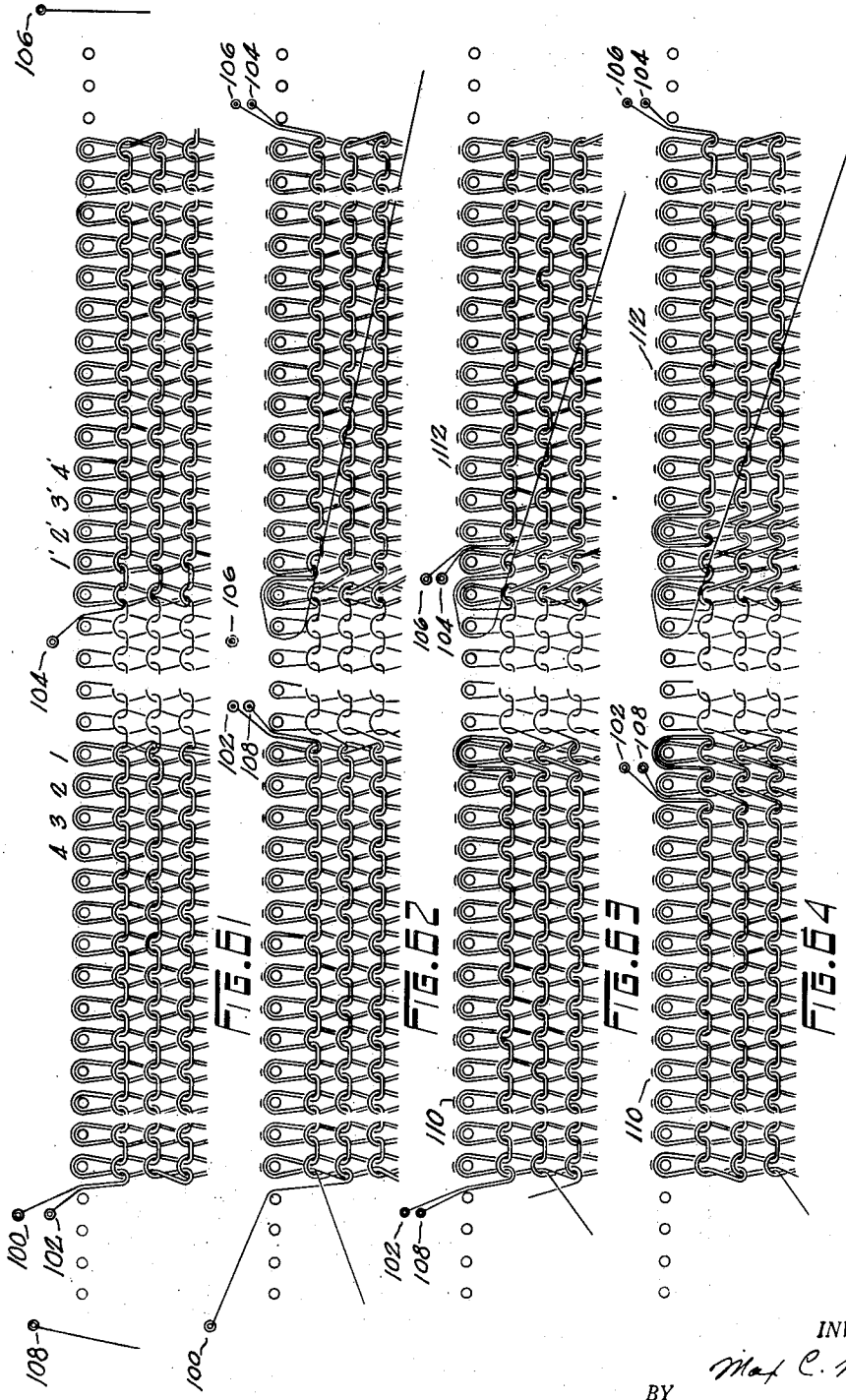


FIG. 61 FIG. 62 FIG. 63 FIG. 64

INVENTOR.
Max C. Miller
BY
Maxwell Fish
ATTORNEY

Nov. 29, 1949 M. C. MILLER 2,489,658

MANUFACTURE OF KNITTED HOSIERY

Filed July 9, 1945 18 Sheets-Sheet 16

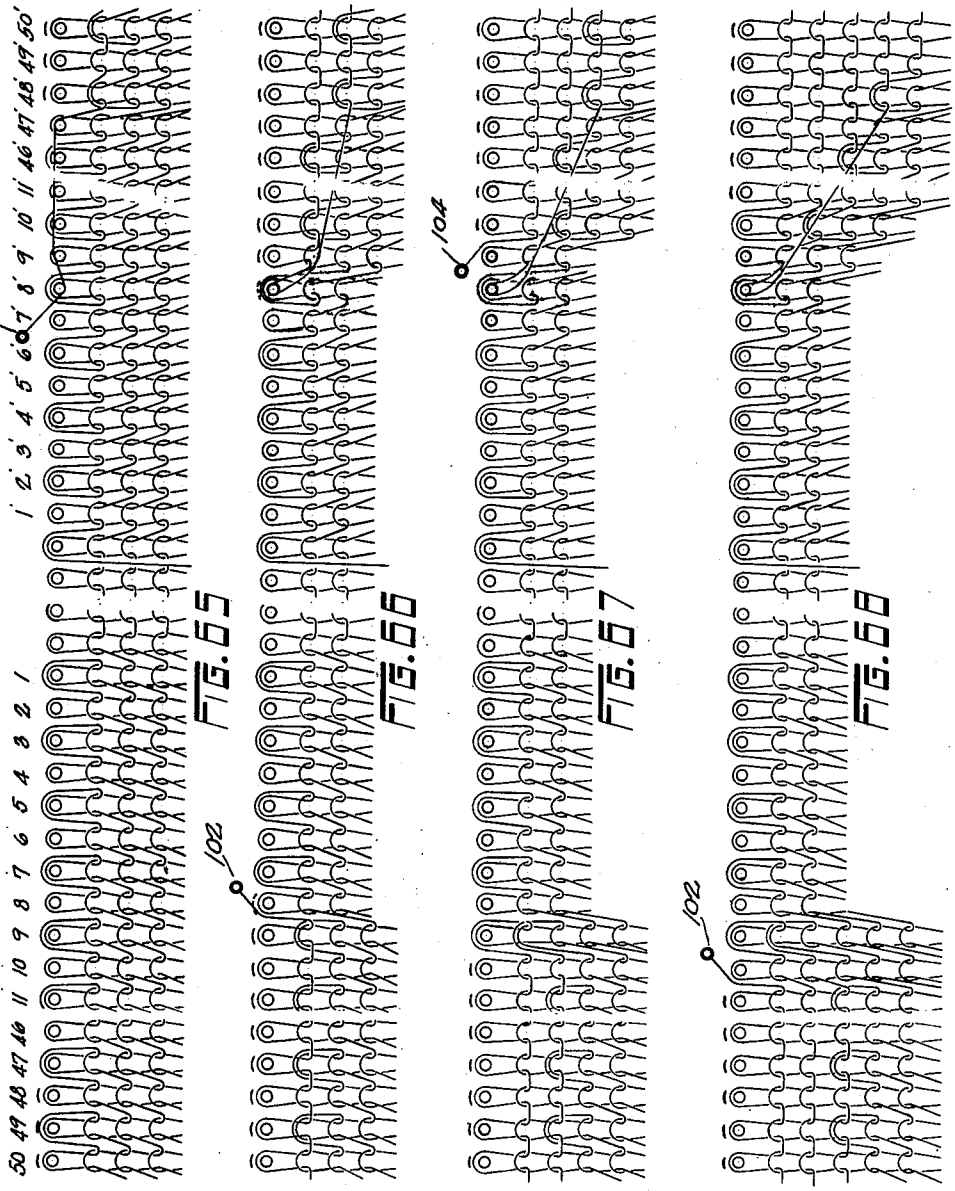


FIG. 65 FIG. 66 FIG. 67 FIG. 68

INVENTOR.
Max C. Miller
BY Maxwell Fish
ATTORNEY

Nov. 29, 1949 M. C. MILLER 2,489,658

MANUFACTURE OF KNITTED HOSIERY

Filed July 9, 1945 18 Sheets-Sheet 17

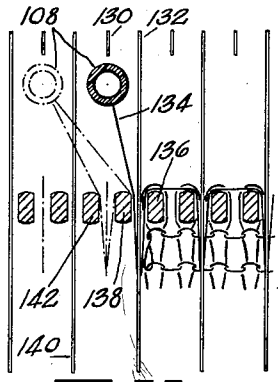


FIG. 69

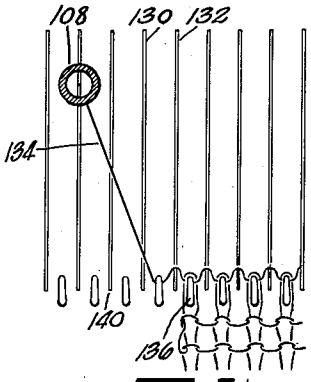


FIG. 71

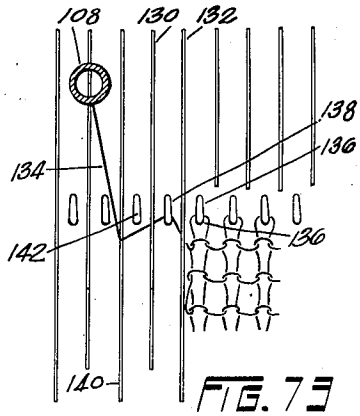


FIG. 73

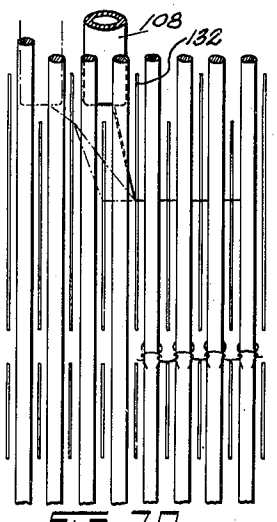


FIG. 70

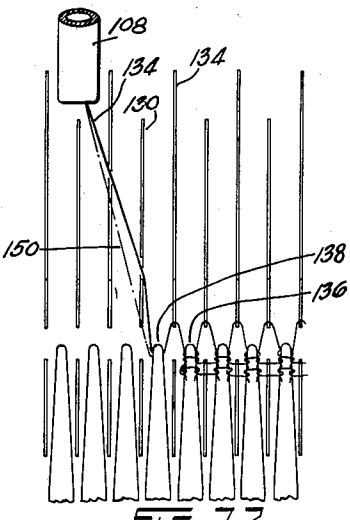


FIG. 72

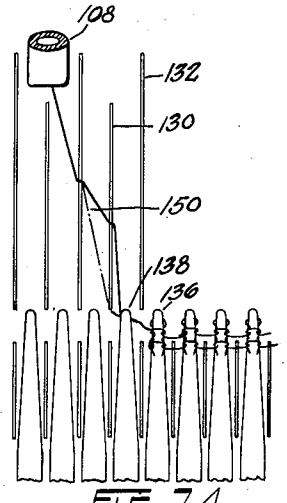


FIG. 74

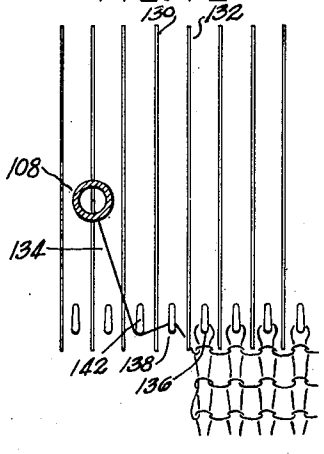


FIG. 75

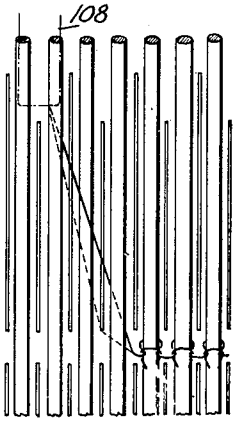


FIG. 76

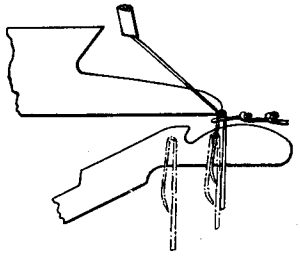


FIG. 66

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Nov. 29, 1949 M. C. MILLER 2,489,658

MANUFACTURE OF KNITTED HOSIERY

Filed July 9, 1945 18 Sheets-Sheet 18

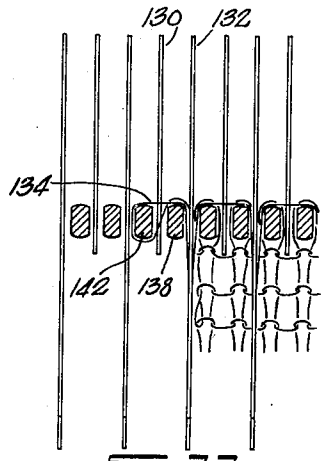


FIG. 77

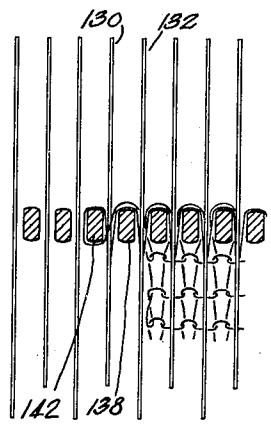


FIG. 79

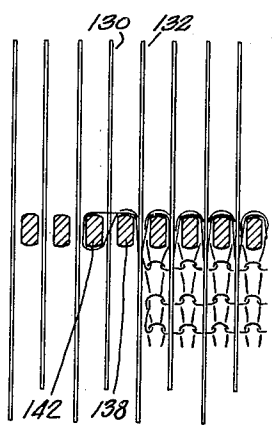


FIG. 81

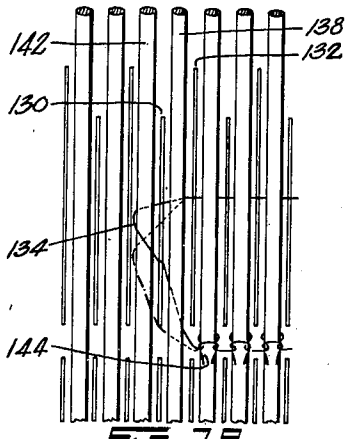


FIG. 78

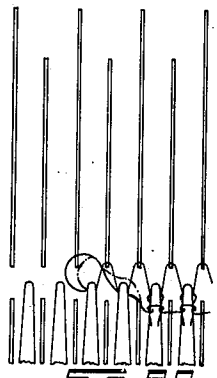


FIG. 80

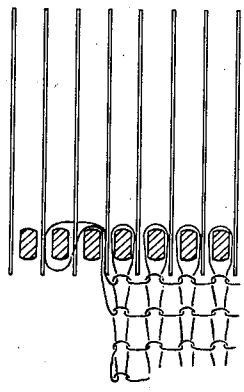


FIG. 82

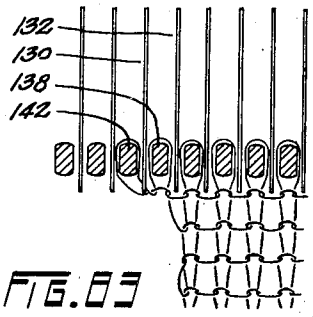


FIG. 83

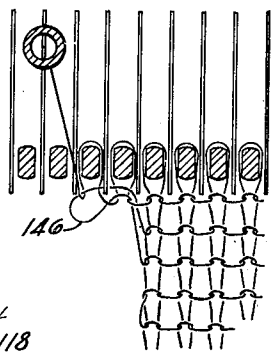


FIG. 84

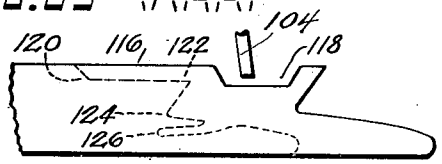


FIG. 85

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UNITED STATES PATENT OFFICE

2,489,658

MANUFACTURE OF KNITTED HOSIERY

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executrix of said Max Curtis Miller, deceased

Application July 9, 1945, Serial No. 603,839½

83 Claims. (Cl. 66—89)

1

The present invention relates to improvements in the manufacture of hosiery, and more particularly to a full-fashioned hosiery blank having a novel and improved heel structure, and to a novel method and machine for knitting the same.

Many efforts have been made to produce a fashioned knitted hosiery blank of improved construction to cause the stocking and more particularly the ankle, heel and instep portions to fit more perfectly the human foot, which could be knitted on available flat full-fashioned type hosiery machines, and which would eliminate certain objectional features of the standard type full-fashioned hosiery blank with square heel sections and ravel end course to be joined together by looping to close the heel. The fashioned hosiery blank of the present invention is knitted with true heels, that is, heels which are formed while substantially no knitting is taking place over the instep of the fabric. While heel structures and methods have been devised for knitting combination foot and leg hosiery blanks having true heels which attempt to achieve to a greater or less extent the precise shape and style of the so-called full-fashioned stocking, such attempts have thus far failed to produce a hosiery blank which is simple in construction or of the proper shape, or which it is practical to produce on existing machines without adding prohibitively to the complication and cost thereof. While full-fashioned hosiery machines have been manufactured which are adapted for knitting combination foot and leg stocking blanks of the full-fashioned type, such machines are complicated and costly, and have had only limited acceptance. Any general shift by the industry to the single machine system of knitting women's full-fashioned hosiery has further been obstructed by the reluctance or inability of mill owners generally to discard existing machines which are in the very large majorty of the so-called "legger type" for knitting the leg and heel portions of the conventional full-fashioned blank, which is then transferred to a footer for the knitting of the foot and toe.

It is one of the principal objects of the present invention to provide an improved full-fashioned hosiery blank and the method of knitting the same, which is readily adapted to be carried out upon the basic legger type of full-fashioned hosiery machine most generally employed in the art.

It is another object of the invention to provide a full-fashioned hosiery blank having a novel and improved heel knitted therein which is

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shaped and integrated with the leg and foot in such a manner as to provide a finished stocking of accurate fit, neat appearance and exceptional strength and durability.

It is a further object of the invention to provide a novel and improved combination full-fashioned foot and leg hosiery blank having the heel portion thereof knitted with a series of gores so located in the fabric and having outwardly widened fabric courses formed therein to provide a heel having the preferred relative dimensions of width and length, and with the leg heel and foot portions joined together by continuous connected knitting of the selvage edges, so that any looping, joining or transfer operations other than the normal seaming operation and toe loop operation for closing the blank are wholly eliminated.

It is another object of the invention to provide a novel and improved method of knitting a heel and foot, or combination foot and leg hosiery blank having a shaped heel in accordance with the invention, and further it is an object of the invention to provide a method of knitting a hosiery blank of this description which is readily practiced upon a conventional single or multiple section Cotton type machine such as those normally employed for the knitting of the leg portion of a full-fashioned hosiery blank with a minimum of alteration or change.

It is a further object of the invention to provide in a Cotton type full-fashioned hosiery machine of this general description, novel features and improvements of construction and mode of operation which will adapt the machine for knitting a hosiery blank in accordance with the steps of the novel method herein described, the foot and leg hosiery blank having the shaped heel herinafter described in accordance with the invention.

In carrying out the invention, an improved fabric blank is provided which comprises with the ankle and foot sections, left and right hand heel areas formed of a plurality of inwardly tapered gores which are so constructed and so arranged with relation one to another as to provide a heel fabric having the desired relative dimensions of length and width with the lower end thereof rounded, and with the terminal wale loops of the heel and instep fabrics connected by continued knitting to the foot portion of the blank so that an unbroken selvage edge of the fabric is maintained extending from the leg, around the heel and along the foot section of the blank.

Features of applicant's improved heel structure

include specifically the construction and arrangement of the heel gores to produce the desired shape and style of heel fabric, the disposition of the gores with respect to one another so that the apex of each successively knitted gore originates in the terminal loop of a different wale of the fabric, the construction of the inner or suture edges of the several gores including the arrangement of the gores so that each gore is formed with a long knitted course connecting the terminal wale loops of the last short course, and the terminal wale loops left during the knitting of the successively shorter courses of the gore, the use of widened courses which are employed at intervals in the knitting of the heel gores to extend outwardly the selvage edge of the heel, the specific arrangement of the loops forming the widened selvage edges to provide a tight, cleanly formed selvage edge, and the construction and arrangement of the left hand gores with relation to the right hand gores of the heel fabric.

Another feature of the invention consists in the provision of a combination full-fashioned type stocking blank which consists of applicant's improved heel structure in combination with the foot and leg portions of the blank, in which the heel and foot portions are knitted as a continuation of the leg knitted with a continuous unbroken selvage edge of the fabric extending the entire length of the leg, heel and foot, and in which the initial width of foot fabric produced by knitting the terminal wale loops of the heel and instep portions is reduced by a substantial number of foot narrowings, and in which the toe is produced by further fabric narrowing operations.

In accordance with the preferred form of the invention, a heel structure is provided which comprises a series of from two to four inwardly tapered knitted heel gores of novel construction which are knitted on groups of heel needles at opposite ends of the needle series while knitting is suspended on the intermediate instep needles on which are supported the terminal wale instep loops.

In this preferred form of the invention, the heel gores are formed with courses starting with a maximum length in the neighborhood of fifty to sixty needle wales, which length is sufficient to produce a first course of heel fabric of the required width, and is within the capacity of a narrowing point unit of about sixty points which is the longest such unit that can be accommodated on a standard multiple section legger type hosiery machine. The successively knitted courses of the heel gore are shortened progressively outwardly one needle at a time by the laying of yarn to more outwardly disposed needles only in successive courses until in the neighborhood of forty-five heel needles have been added to the inactive series at each end of the instep group. Further in accordance with the preferred form of the invention, the first long course of the next or second gore is formed with its most inward loop placed from 6 to 8 needle indexes outwardly from the innermost loop of the longest course of the preceding gore, and the first long course of the next succeeding or third gore is located with its most inward loop placed again 6 to 8 needle indexes outwardly from the innermost loop of the preceding gore. During the knitting of the heel courses, the heel yarns are fed outwardly to additional needles in selected courses to form successive two needle widenings. In the example above stated, and as shown in Fig. 45 of the drawings, four such selvage needle widenings will serve to maintain a continuous selvage edge of the fabric from the first to the second and then to the third gore located outwardly with respect to one another as above set forth.

Steps of applicant's novel method of knitting to produce a hosiery blank with a shaped heel in accordance with the invention, include knitting series of heel courses upon selected variable groups of needles without resort to needle narrowing or similar loop transfer operations while holding terminal wale loops of intervening instep and heel fabric wales with respect to which no knitting has taken place, and in such manner knitting at each side of the fabric a heel gore with a series of successively shorter courses, thereafter knitting one or more additional heel gores thereto arranged so that the long course forming one side of each gore in the series is employed to connect the terminal loops of heel wales left by the successively shorter courses of the next adjacent gore, and the inner apexes of the several succeeding gores are connected with terminal loops of different wales of the fabric, and at intervals during the knitting of said heel courses adding loops outwardly in selected courses in order to produce the required width and length of heel fabric with a rounded heel and with a continuous selvage edge of said fabric extending from the leg entirely around the heel and thence along the foot portion of the blank, and thereafter knitting a course connecting all of the terminal wale loops of the fabric including the terminal wale loops of the instep and adjacent heel fabric wales with respect to which no knitting has been taking place and the loops of the previous course of knitting to form the first course of the foot portion of the blank.

Other steps and details of the novel method herein disclosed including alternative ways of performing certain steps of the method, will be more fully set forth in the following detailed description of the method. Features and steps of applicant's novel method which relate more specifically to the method of manipulation and operation of a flat full-fashioned type hosiery machine for the knitting of the hosiery blank of the present invention thereon, will be more fully set forth in connection with the following description of such a machine in which are embodied the several novel features of construction and operation in accordance with the invention.

The machine herein disclosed in the drawings as embodying the several features of the invention is a 45 gauge multiple section full-fashioned Cotton type hosiery machine which is provided with the usual mechanisms, attachments and control devices normally provided in a machine of this general type adapted for knitting the leg and heel portions of a full-fashioned hosiery blank. In accordance with the present invention, certain alterations and improvements have been made in such a machine to permit a combination foot and leg hosiery blank with the novel shaped knitted heel herein described to be produced thereon. It will be understood that the several features of the invention are not limited in their application to the particular machine organization shown, and that these features may be employed to adapt multiple section machines other than leggers and single section machines of the so-called Cotton type for the knitting of the improved hosiery blank of the present invention in accordance with the method herein illustrated.

A feature of the invention consists in the arrangement and mode of operation of the narrowing point units of the machine in cooperation with the needles as beard closing elements to effect the knitting of the heel courses upon groups of heel needles in varying number while the terminal wale loops of the instep and adjacent heel portions of the fabric with respect to which no knitting is taking place are held on the inactive instep needles and on such heel needles as may be added to the inactive instep group. In the preferred form of the invention illustrated, mechanism is provided for rocking the narrowing points rearwardly to an alternate fixed position toward the press from the normal narrowing position, and additional means are provided for controlling the vertical movements of the narrowing machine and for imparting cooperating movements to the needles particularly with respect to the needle forward and back or press motion to cause only those needles to knit which are engaged by the beard closing narrowing points.

Another feature of the invention consists in the provision of a novel and improved operating and control mechanism for indexing the narrowing points including mechanism operable to cause the groups of heel knitting beard pressing narrowing points to be stepped outwardly one needle at a time in successive courses for the knitting of the successively shorter heel courses of the heel gores, and to cause the narrowing point units to be shifted rapidly inwardly over a relatively large number of needle indexes between successive courses for the knitting of the first long course of the next succeeding gore. In the preferred form of the invention, an electric motor drive is provided for traversing the narrowing point units inwardly the relatively large distance required upon completion of the operation of pressing the beards for the knitting of the last short course. In this operation the narrowing point units are preferably moved inwardly one index beyond the desired position, and are then moved outwardly again by means of a spindle racking operation to accurately position the point units with respect to the needles.

Another feature of the invention consists in a novel arrangement of the operating controls for the heel yarn laying carriers of the machine to cause these yarns to be fed to varying groups of heel needles, and includes carrier stop mechanism which acts in cooperation with the beard closing narrowing point unit control mechanism to feed yarns only to the active heel needles for the knitting of the successively shortened courses of the heel gores, for knitting the first long course of each succeeding gore, and for forming widening selvage loops on added needles at intervals during the knitting of the heel courses.

Another feature of the invention consists in the novel arrangement and mode of operation of the knockover bits which are of the nibbed type rigidly mounted to move as a unit on a knockover bit bar, to cause these elements to be supported resiliently in a raised forward position to knock over and to position newly formed loops to the back side of the needles, and to cause these elements to be moved positively to a relatively retracted inoperative position during the remaining portion of the knitting cycle, so that the knockover bits are permitted to move forwardly only as the needles start to draw their loops off the ends of the sinker noses, and are again moved to their rearward position as the needles

rise from the knockover level. In accordance with the invention, the knockover bits operating in the manner above described, cooperate with the active heel needles during the knitting of the gored heels to knock over the loops of the heel courses, and at the same time cooperate with the inactive instep and adjacent inactive heel needles to engage with and hold down the fabric supported thereon. The knockover bits operating in this manner cooperate also with all the needles during normal knitting across the needle series to knock over and hold down the sinker wale loops. Further in accordance with the preferred form of the invention, the nibbed knockover bits moving in accordance with a special narrowing cycle of operation, are arranged to cooperate with the narrowing points during ordinary narrowing operations to engage their nibs with and to hold down the fabric loops only during the last portion of the narrowing operation in which the points are moved upwardly out of engagement with the needles to the high inoperative position.

In accordance with another feature of the invention, the narrowing point indexing and control mechanism is so constructed and arranged as to permit one of the groups of narrowing points to be moved to and be latched in an inward position while the other group of narrowing points remains in an outward position for the knitting of courses of different length in the formation of the left and right heel sections in a single traverse of the slur-cock and yarn carrier driving mechanism of the machine.

A further improvement in accordance with the invention, consists in the provision of sinkers which are cut away along their upper edge so that the yarn carrier can be shifted lengthwise of the needle series to re-position the yarn with relation to the knitting instrumentalities during that portion of the knitting cycle following the kinking of the yarn by the sinkers and while the sinkers are fully advanced for effecting the fabric shaping operations hereinafter described.

Other features of the invention relate specifically to the construction and arrangement of the pattern and control devices of the machine to coordinate the several operating mechanisms for operation in accordance with the procedures employed as herein set forth in carrying out the method of the present invention.

The several features of applicant's improved hosiery blank, the novel method of knitting the same, and the features of the flat full-fashioned type machine employed for knitting this hosiery blank in accordance with applicant's method, will be readily understood by one skilled in the art from the following description taken in connection with the accompanying drawings, in which:

Fig. 1 is a cross section looking from the left of a multiple section full-fashioned hosiery knitting machine constructed and arranged for the knitting of hosiery blanks in accordance with the invention, only so much of the machine being shown as is believed necessary to indicate the connection of the invention therewith;

Fig. 2 is a fragmentary view in front elevation of the mechanism indicated in Fig. 1 for rocking the narrowing point units;

Fig. 3 is a fragmentary plan view of this mechanism as shown in Figs. 1 and 2;

Fig. 4 is a view in front elevation showing a portion of the length of the machine to illustrate particularly certain of the operating mech-

anisms and control for the needle series and narrowing point units;

Fig. 5 is a sectional view looking from the left taken on the line 5—5 of Fig. 7, illustrating particularly the mechanism for actuating and controlling the carrier stop traversing spindles, the carrier stop lifting and lowering device, and the narrowing point unit racking spindle and stop devices thereof;

Fig. 6 is a fragmentary sectional view looking from the left, illustrating on an enlarged scale the carrier racking controls switch indicated in Fig. 5;

Fig. 7 is a plan view of a portion of the length of the machine illustrating particularly the parts shown in Figs. 1 and 5;

Fig. 8 is a fragmentary plan view of the stops for the inner carrier stops and for the narrowing point unit mechanism shown in Fig. 7;

Fig. 9 is a sectional view of the stop mechanisms shown in Fig. 8, being taken on the line 9—9 of Fig. 8;

Fig. 10 is a view in front elevation of portions of the machine illustrating particularly the two ends of the machine, and with the middle portions thereof omitted to illustrate particularly the pattern chain mechanism and the several pattern control rods associated therewith for the operation of the several mechanisms hereinafter described and shown;

Fig. 11 is a fragmentary view in front elevation illustrating particularly the construction of the pattern chain mechanism;

Fig. 12 is an end view of the mechanism shown in Fig. 11;

Fig. 13 is a cross setional view taken on the line 13—13 of Fig. 11;

Fig. 14 is a fragmentary sectional view showing one of the pattern sprocket wheels and the relationship of the pattern chain thereto;

Fig. 15 is a fragmentary sectional view of the parts shown in Fig. 14 looking from the left;

Fig. 16 is a fragmentary cross sectional view looking from the left of the machine illustrating a portion of the inner carrier stop lift mechanism showing the carrier in its raised position;

Fig. 17 is a view similar to Fig. 16, showing the carrier stop lowered to its lowest position;

Fig. 18 is a somewhat fragmentary cross sectional view looking from the left of the machine, illustrating particularly the narrowing point units and the actuating mechanism adapted for reversing and for outwardly racking the narrowing point stop traversing spindles;

Fig. 19 is a fragmentary end view in section looking from the left of the machine and illustrating particularly the knockover bit bar and its related supporting and operating parts;

Fig. 20 is a plan view of the mechanism shown in Fig. 19;

Figs. 21 to 28 inclusive, are a series of somewhat diagrammatic views illustrating successive steps in the operation of the narrowing point units in cooperation with the needles and other knitting instrumentalities for needle beard covering;

Fig. 29 is a somewhat fragmentary plan view illustrating particularly the outer carrier stops and the related mechanism for arresting the outward traverse of the four heel yarn carriers herein described;

Figs. 30 to 32 inclusive, are diagrams showing the relationships of the needles, heel yarn carriers and loop lifting narrowing points in a series of positions to illustrate the operation of these

parts at the start of the knitting of a new heel gore;

Fig. 33 is a composite diagrammatic drawing showing the outlines of certain of the operating cams of the machine and their follower rollers in operating relation to each other;

Figs. 34 and 35 are diagrammatic views illustrating the relation of the sinkers, dividers and the heel yarn carrier to illustrate a preferred method of forming the inner or suture edge of the heel gore to leave a full loop on each successively idled heel needle;

Fig. 36 shows the several cooperating knitting instrumentalities including the needles, sinkers and dividers in position at the completion of the knitting cycle after the yarn carrier has been traversed again outwardly to the left for the knitting of the next succeeding course;

Fig. 37 is a diagrammatic drawing illustrating the relative dimentions of the foot and ankle of a stocking blank;

Fig. 38 is a cross sectional view taken on the line 38—38 of Fig. 37;

Fig. 39 is a cross sectional view taken on the line 39—39 of Fig. 37;

Fig. 40 is a diagrammatic view of the lower portion of a stocking blank showing the three gore heel in accordance with the invention in its relation to the high splicing and sole narrowings;

Fig. 41 is a diagrammatic view in full lines of the lower portion of a seamless stocking blank on which is superposed in dot-and-dash lines, applicant's full-fashioned stocking blank;

Fig. 42 is a diagrammatic plan view of the toe portion of a stocking blank illustrating a simple method of toe narrowing;

Figs. 43 and 44 are diagrammatic views of the ankle and foot portions of stockings blanks in which somewhat different arrangements of the heels gores are shown in accordance with the invention;

Fig. 45 is a diagrammatic view on an enlarged scale of the left hand heel of a stocking blank constructed in accordance with the invention;

Fig. 46 is a fragmentary diagrammatic view showing the loop structure of the three-segment left hand heel of Fig. 45 on a still larger scale;

Fig. 47 is a fragmentary view showing the loop structure produced in accordance with a preferred form of applicant's method of forming the suture line as shown in Figs. 34 to 36 inclusive.

Fig. 48 is a somewhat fragmentary view showing on an enlarged scale the loop structure of a four gore heel such as that illustrated in Fig. 51;

Fig. 49 is a fragmentary drawing on an enlarged scale showing a left heel fabric widening operation in accordance with a preferred form of applicant's method in which a true loop is formed on the inner of the two added needles upon the return or reversing stroke of the yarn carrier;

Fig. 50 is a fragmentary drawing showing the loop structure of a left hand heel selvage widening in accordance with another form of applicant's method;

Fig. 51 is a diagrammatic view of a four-segment left hand heel of a full-fashioned stocking blank;

Figs. 52 to 60 inclusive, are a series of views showing the relative positions of the narrowing points, needles, sinkers and nibbed knockover bits in a series of stepped positions for the performance of a narrowing operation in accordance with applicant's improved method;

Figs. 61 to 64 inclusive, are a series of somewhat diagrammatic views of the needles, the fabric

supported thereon, the beard closing narrowing point units, and the body and heel yarn carriers illustrating the method of operation of the yarn carriers and narrowing point units for the knitting of the first course of the first left and right heel fabric gore in accordance with one form of the invention;

Figs. 65 to 68 inclusive, are somewhat diagrammatic views illustrating the fabric, the needles, the left and right heel beard closing narrowing point units, and a left and right heel yarn carrier illustrating the completion of the knitting of one gore and the knitting of the first course of the next succeeding heel gore in accordance with one form of the invention in which the right hand heel yarn carrier is moved inwardly in advance of its normal operation in order to eliminate the eyelet which would otherwise appear at the apex of the gore suture line of the right hand heel;

Figs. 69 to 84 inclusive, are enlarged diagrammatic views illustrating the needles, sinkers, dividers and the heel carrier knitting the left heel in a series of positions taken in forming a widened selvage edge in accordance with the method of the present invention. In these views two different methods of forming the selvage are shown, the position of the yarn in accordance with one method being shown in full lines, and the position of the yarn in accordance with the other method being shown in dot-and-dash lines where this position differs from the full line position shown;

Fig. 85 is a fragmentary view in side elevation illustrating a particular form of jack sinker and associated divider which are employed in carrying out the method of selvage formation illustrated in Figs. 69 to 84 inclusive, and in carrying out the method of loop formation at the inner ends of the successively shortened courses of the heel gores as shown in Figs. 34 to 36 inclusive, and 47; and

Fig. 86 is a somewhat diagrammatic view in side elevation of the needles, sinkers, the nibbed knockover bits and the yarn carrier knitting the left hand heel illustrating the manner in which the needles are rocked somewhat outward beyond their normal position as the needles move downwardly to the knockover level to cause the portion of the yarn extending from the last knitted loop to the carrier to pass under the adjacent divider in accordance with the alternative form of applicant's method of knitting a widened selvage edge shown in the dot-and-dash lines in Figs. 69 to 84 inclusive.

Fig. 87 is a fragmentary detail view in front elevation of the torque control rod and its actuating cam forming part of the control mechanism for effecting rapid inward movement of the inner carrier stops in accordance with the invention.

In accordance with the invention, applicant provides a combination foot and leg full-fashioned hosiery blank having knitted therein a novel and improved shaped heel which is particularly adapted to be produced in accordance with applicant's method hereinafter more fully set forth, both fabric and method being well adapted for the production of the combination blank on a multiple section full-fashioned "legger" hosiery machine with the improvements and modifications of structure and operation hereinafter set forth. The heel which forms more particularly the subject-matter of the invention, comprises a plurality of successively knitted gores constructed and arranged with respect to one another to produce a heel of the desired width and length in which all terminal wale loops are connected by continued knitting to the foot portion of the blank, and in which unbroken selvage edges are maintained in the continued knitting of the leg, heel and foot.

In the preferred form of the invention, a group of three knitted gores is employed as shown in Fig. 45, designated at *a*, *b* and *c*, although it is contemplated that a series of from two to four or even more gores can be knitted to produce a heel fabric having the desired characteristics of appearance and shape to fit the human foot. In accordance with the disclosure of Fig. 45, the segments employed take the form of inwardly tapered gores of which the longest course may be 56 loops in length and of which the shortest course may be 18 loops in length in order to provide a sufficient body of fabric adjacent the selvage edge. In the form of the heel shown in Fig. 45, gores *a* and *b* are formed with widened courses occurring at intervals to form a widened selvage edge, and the successively knitted gores *b* and *c* are preferably located successively outwardly each with respect to the preceding gore in order to give the heel its characteristic shape and appearance. It will be understood that the shape of the fabric produced in accordance with the invention is flexible within wide limits, and may be readily altered by varying the amount of the widening at the selvage edge and by altering the number and relative positions of the gores. In the preferred form of the invention, a heel having a length approximately one and a half times the width and consisting of three gores is employed substantially as shown in Fig. 45, and provides a most satisfactory form of heel. In this connection, reference may be had to Figs. 37, 38 and 39 of the drawings, which disclose a model of the human foot of standard proportions, Fig. 38 being a cross section across the ankle to illustrate the amount of fabric which is employed in the forming of the upper end of the heel, and Fig. 39 being a cross section taken across the instep and foot at the point of juncture of the heel therewith to illustrate the somewhat greater amount of fabric required at this point in the knitting of the stocking blank. The difference in the length of outline of Figs. 38 and 39 indicates that a heel having a length of substantially one and a half times its width is required to produce a properly fitting stocking.

Further in accordance with the preferred form of the invention, it is contemplated that the several gores will be knitted in a substantially similar manner starting with the long course and proceeding with the knitting of successively shorter courses, the terminal wale loops left by the successively shortened courses and the terminal wale loops of the last short course being connected by the first long course of knitting of the next succeeding gore. Figs. 40, 43 and 44 illustrate respectively alternate forms of heel in which three, four and five gores respectively are employed in the knitting of the heel. Fig. 41 illustrates in solid lines, for purposes of comparison, a bag-type heel in which no widening of the fabric gores is employed, so that an undesirable downward dip is produced in the shape of the foot as compared with the preferred shape illustrated in dot-and-dash lines in this figure. The heel knitted in accordance with the invention, is a true heel in that little or no fabric is formed across the instep during the knitting of the heel gores, although it is contemplated that an occasional course as, for example, one or several courses following the knitting of each successive gore may be so knit-

ted across the entire width of the fabric in order to avoid marking of the fabric through straining of the held instep loops. Further, by including such courses, it will be understood that a different construction of the heel gores with relation to one another may be employed without the forming of objectionable eyelets such as those produced where gores are formed in pairs by the knitting of successively shorter courses for the formation of one gore and successively longer courses for the formation of the next succeeding gore to produce the bag heel of Fig. 41. It will be understood that the illustrated machine is well adapted for the knitting of such interposed courses extending across the entire width of the fabric upon completion of the knitting of a right and left gore and prior to the knitting of the next succeeding right and left gore. The procedure is to render the heel knitting mechanism inoperative and to put in operation a body carrier which will then knit entirely across the fabric in the manner set forth on the last page and paragraph of the specification for the knitting of the first course of foot fabric. For the knitting of the first course of the next succeeding right and left gore, the heel knitting mechanism is again placed in operation in the manner set forth for the knitting of the first left and right heel gore, reference being had to the last section of the specification relative to the operation. Assuming that such full length courses are interposed between successive gores, it will be understood that the advantages of the invention may be obtained from knitting any one or more of the gores located with relation to one another and formed with widened selvage edges as above set forth, but starting with the shortest rather than the longest course as here shown, and thereafter knitting successively longer courses adding active needles at the inner or suture edge of the gore.

Certain features of applicant's improved heel relate to the construction and arrangement of the loops forming the inner or suture edge of the successively knitted heel gores in which the terminal wale loops left on inactive needles during the knitting of the successfully shorter heel gore courses are subsequently joined to the fabric by the knitting of a long course connecting therewith, and other features relate to the provision of an improved loop structure forming the widened selvage edges of the successively knitted heel gores. In accordance with one form of the invention as shown, for example, in Figs. 45 and 46 of the drawings, the inner or suture edge of each heel gore formed by the juncture of the terminal wale loops of successively shortened heel courses with a following long connecting course is knitted with alternate plain and tucked loops in successive courses. An alternative and it is believed preferably form of suture is illustrated in Fig. 7, in which a true loop is formed and is left in the knitting of each successively shortened course of the heel gore to form a less marked suture line. Further details of these constructions will be pointed out in connection with the description of the method of knitting the heel gores.

In accordance with the invention, applicant provides an improved loop structure providing a two-needle widened selvage edge of the heel gores. In each of the two constructions shown in Figs. 49 and 50 of the drawings, the yarn is laid to the needles in such a manner as to cause a loop to be formed upon the inner of the two added needles, and a loop to be formed upon the outer of the two added needles during the second or reverse course of yarn laying from the widened selvage on the selvage needle by wrapping the yarn around the selvage needle. In one form of the invention shown in Fig. 50, the loop formed on the inner of the two added needles is tucked in the first or widened course and is tucked again together with the second loop formed in the return or reverse course, and a true loop is then formed as the yarn carrier again returns to the selvage edge for the laying of the third course upon the wider group of needles. With this form of selvage, the wales forming the widened fabric area are properly locked into the fabric at the point of starting, but the tucking of the yarn in the two successive courses upon the inner or first added needle is one cause for the leaving of an undesirable amount of slack yarn, as shown in Fig. 50. In the alternative and preferred construction of Fig. 49, it will be noted that a true loop is formed in the return course of knitting away from the widened selvage edge. As will hereinafter appear in connection with the following description of the several steps of applicant's method, this difference in loop structure is effected by causing the first added needle to cast off the widening course yarn kink during the second or reverse course of knitting of the carrier away from the selvage edge. With this form of loop structure shown in Fig. 49 and knitted in accordance with the method hereinafter more fully set forth, an extremely firm and compact fabric selvage edge is achieved at the point of widening.

A further feature of applicant's improved fabric blank consists in the construction and arrangement of the knitted fabric with right and left gored heels produced simultaneously on a standard type flat hosiery machine in which the coulier stroke in either direction cooperates with the needles and associated knitting elements including sinkers and dividers in a different manner for the knitting of the left and right heel courses. In accordance with one form of the invention in which it is proposed to knit the first course of heel fabric simultaneously for the formation of both the left and right heels, the first course of knitting of each successive gore in the formation of the right hand heel, assuming a carrier traverse from left to right, will be formed with the yarn at its starting end intertwined with one or preferably a substantial number of adjacent instep or previously inactive heel course loops in order to close the eyelet which would otherwise be formed at the inner apex of each right hand heel gore. Further, in accordance with one form of the invention in which the heel gore sutures are formed with alternate loops and tucked loops on the reversing needles, it will be noted that these tucked loops appear for the left and right hand heel sutures in staggered alternate courses, as also do the two-needle selvage edge widened courses for the left and right heels. In an alternative form of the invention, the left and right heels are formed with the corresponding courses in the left and right heels out of step with one another by one course, the first course of left hand knitting being one course in advance of the first course of right hand knitting, this correspondence being maintained during the entire knitting of the heel. Further details of the construction of the heel fabric above mentioned will appear in connection with the following description of the various forms of applicant's method of knitting a fabric with his improved heel.

Further in accordance with the invention, the

stocking blank produced is formed with a continuous unbroken selvage edge which extends from the leg or ankle portion of the blank around the entire heel, and joins with the leg and foot. The looping operation normally employed for securing together the ravel ends of heel tabs produced in the knitting of the ordinary full-fashioned stocking blank is entirely eliminated, and the operator is enabled to seam around the entire heel edge with a consequent saving in time and improvement in appearance and strength of the completed article. A heel knitted with a series of gores constructed and arranged as herein set forth is curved at its lower end and tends to assume a pouch-like shape so that it fits more accurately the rounded shape of the human foot than the ordinary full-fashioned heel construction normally employed.

The heel structure of the present invention combines in an improved manner with the leg and foot sections of the blank to form a more perfectly fitting stocking. It will be understood that the rounded heel of the present invention may be finished off when so desired with narrowing courses to further enhance the pouch-like shape of the heel, and it is contemplated that in the knitting of the foot section of the blank, further shaping of the foot fabric will take place, being produced by means of foot narrowings which are in accordance with the usual practice except that a substantially larger number of such narrowings have been found desirable to properly narrow the foot in view of the greater fullness of the heel structure produced in accordance with the present invention. The elimination of the usual looping operation to close the heel and the substitution of a continuous seaming operation therefor extending the full length of the leg, heel and foot fabrics makes possible a closer and more accurate shaping of the blank and particularly the heel and foot to a predetermined standard shape.

For the knitting of the inwardly pointed or shaped toe portion of the hosiery blank, a series of two-needle narrowing operations may be employed to produce a shaped toe utilizing the left and right narrowing point units which are employed also for the leg narrowings and for closing the beards of the heel needles during the knitting of the heel fabrics above set forth. Since the use of narrowing operations of this character to form the shaped toe of a hosiery blank is well known in the art, no further description of the knitting of the toe is necessary.

In accordance with the invention, a novel and improved method of knitting a combination foot and leg full-fashioned hosiery blank having the shaped knitted heel above described, has been devised which is well adapted to be practiced on any Cotton type full-fashioned hosiery machine of either the single or multiple-section type, and more particularly on a multiple-section full-fashioned "legger" hosiery machine which may be of ordinary description, but with certain modifications as hereinafter more fully pointed out. With the method herein described, the shaped heel fabric portions of the blank are produced by knitting on selected groups only of the needles comprising each knitting section, these groups being located toward the outer ends of the needle series, and by adding needles to and subtracting needles from the groups upon which knitting is taking place in accordance with a predetermined pattern while the terminal wale loops of the instep portion of the fabric and the terminal wale loops left by the successively shortened heel courses are held on the inactive instep and adjacent heel needles as these are added to the inactive series.

In accordance with the invention, the shaping of the heel fabrics is effected solely by the control of the heel yarn carriers to feed yarn to selected numbers of needles in successive courses, and without resort to loop transfer operations of any description. The heel needles are caused to take yarn and to knit successive heel courses while the intervening inactive instep needles and heel needles added to the inactive series remain inactive with their terminal wale loops held thereon by a novel cooperation of the knitting instrumentalities of the machine which includes the employment of narrowing points as needle beard pressing elements in a knitting cycle of operation with the needles, the narrowing points being mounted in units of a width equal to the width of heel fabric knitting, and a novel arrangement and mode of operation of cooperating nibbed knockover bits for knocking over and positioning the newly formed fabric loops to the backs of the needles, and for holding down the loops held on inactive needles without injury thereto.

In accordance with the method of the present invention, racking movements are imparted to the narrowing point units, and cooperating adjustments are made in the positions of both the inner and outer carrier stops for the heel carrier needles for the knitting of the successive heel courses including the rapid positioning inwardly of the narrowing point units and inner carrier stops for the knitting of the first long course of each successive gore. Further in accordance with the invention, a novel system of control of the right and left heel carriers and of the narrowing point units associated therewith is provided to facilitate the simultaneous knitting of right and left heel fabrics on a flat full-fashioned type hosiery machine.

Further in accordance with the method of the invention, stepped positioning movements outwardly are imparted to the heel yarn carriers subsequent to the normal yarn laying stroke thereof for effecting periodic two-needle widenings of the fabric selvage, and also for feeding yarn to more outwardly disposed needles at the inner edges of the heel knitting for the formation of the successively shorter courses of the heel gores. Other features of the invention relating more particularly to the method of operation of the machine will be more fully set forth in connection with the following description of the machine and its operation.

In the preferred form of the invention, the gores comprising successively shortened courses are formed by a single stepped outward racking of the beard closing narrowing points upon the knitting of each course accompanied by a two-stepped outward racking of the carrier stops for the carriers forming the heels upon alternate courses. The courses are widened as desired at the outer ends by moving the outer carrier stops outwardly to add two needles at a time in the knitting of selected courses.

The several steps of the method of knitting the improved shaped heel of the combination foot and leg full-fashioned hosiery blank in accordance with the present invention will be described as follows:

As shown in Fig. 46, the heel is formed of three segments or gores *a*, *b* and *c* respectively. Seg-

ment *a* is the first portion of the heel to be formed, and consists essentially of a gore in which the starting course is of a predetermined width. It is assumed that the illustrated machine is a 45 gauge machine, and that the first knitted heel course is 56 needles wide. This segment or gore is formed one needle narrower at the end of each course, the yarn of each inward stroke in accordance with one form of the invention forming a double loop on a reversing needle which is always selected so that there is a jack sinker immediately adjacent and inwardly thereof to insure that the reversing needle can have yarn fed to it properly. On the subsequent outward carrier traverse, this reversing needle does not have its beard closed so that it forms a tuck stitch in the following course. All of the remaining needles to which yarn is fed including the next outwardly adjacent needle form loops in the normal manner. During the next inward traverse of the carrier, yarn is fed to a reversing needle two needles outwardly removed from the first reversing needle, and again on the reverse outward stroke of the carrier, the yarn is tucked on the reversing needle while the remaining outwardly disposed needles form loops in the normal manner. At intervals during the knitting of the heel courses of gore *a*, the fabric is widened outwardly at the selvage edge in order to impart to the finished heel fabric the desired characteristic shape, and to provide a continuous selvage edge connecting with the next succeeding similarly formed outwardly disposed gore *b*. For widening at the selvage, the empty needles are added two at a time at the outer end of the active group at recurring intervals as shown in the drawing Figs. 45, 49 and 50.

After forming the first segment or gore *a* with, for example, 47 successively shortened courses in which 47 needles are rendered successively inoperative at the inner selvage for the left hand heel, and with four fabric widenings so that, for example, 18 loops are left in the last short course, the second heel segment or gore *b* is formed, the first or inward traversing course of which goes to a reversing needle, let us say, the ninth needle outwardly from the first reversing needle employed in knitting the first heel segment, and thereafter, the fabric gore *b* is formed in the same manner as gore *a* above described, until knitting has again taken place through 47 successively shortened courses up to the 47th reversing with 47 needles having been rendered successively inoperative at the inner selvage or suture edge of the heel fabric, thereby completing the second heel segment with an outward carried traverse from the 47th needle, empty needles again being added at the outer end of the active group at recurring intervals as indicated in Fig. 45 of the drawing.

Thereafter the third heel segment or gore *c* is knitted. Commencing at the outer selvage for the left hand heel, the traverse goes to a reversing needle which may be taken as the 17th needle counting outwardly from the first reversing needle of the first heel segment or gore *a*, and thereafter this third segment or gore *c* is formed in a manner similar to that described for the first and second gores *a* and *b* respectively, until the knitting to and from the reversing needles forming progressively shorter courses of the gore has progressed so that there are only, for example, 18 needles active. This completes the knitting of the heel, and the first sole course is now formed, feeding from left to right across the left hand heel through the instep and then across the right hand heel which has been knitted simultaneously with the knitting of the left hand heel.

Figs. 61 to 64 inclusive, illustrate a system of carrier control in accordance with the invention for the simultaneous knitting of the first course of left and right heel fabrics during the same coulier stroke of the machine, and for causing the yarn at both inner heel selvages to be knitted immediately into the instep portion of the fabric held on the inactive instep needles and thus to avoid the formation of an objectionable eyelet hole particularly in the inner corner of the right hand heel gore. At the completion of the slur-cock stroke from right to left in the last course of leg fabric prior to the knitting of the heels, the positions of the active yarn carriers will be as shown in Fig. 61. The leading yarn carrier designated at **100** is standing at the outer edge of the left hand splicing and will be placed in an idle position before the next traverse of the slur-cock. The left hand splicing carrier **102** is standing at the outer edge of the left hand splicing, while the right hand splicing carrier **104** is standing at the inner edge of the right hand splicing. At the right and left idling positions are the carriers **106** and **108** respectively, that are to be used as reinforcing yarn carriers in the following traverse from left to right.

Before the knitting of the last course is completed, however, the machine is stopped with the needles down (see Fig. 25) and the sinkers retracted, at the knocking-over position. The carrier **106** is now traversed manually to the position shown in dot-and-dash lines in Fig. 45, so that in the following traverse from left to right, the two right hand carriers **104** and **106** lay yarns from the inner edge of the right hand splicing outward so that this course is in effect the first course of heel knitting for both the left and right heels. This is the position shown in Fig. 62. The object of manually moving the carrier **106** to the dot-and-dash position of Fig. 62, is to lay a connecting yarn starting preferably several needles inwardly from the edge of the instep portion of the fabric so that it will extend across to the heel kniting needles, and thus avoid the formation of a large eyelet hole which would otherwise appear at the inner selvage of the right hand heel. Prior to the knitting of the course shown in Fig. 62, the body carrier **100** is moved to an idling position, while the carrier **108** shown idle in Fig. 61 is rendered active, and in the knitting of the course shown in Fig. 62, functions as one of the two left hand splicing carriers.

Prior to the knitting of the first heel course of Fig. 62, the machine is conditioned for the knitting of the shaped heel fabrics while the terminal wale loops of the instep fabric are held with no further knitting taking place on the instep needles. The left hand narrowing point unit **110** and the right hand narrowing point unit **112** are now moved simultaneously inwardly to the positions shown in Fig. 62 to be used as beard pressers. Other changes in the operating condition of the machine taking place at this time, as hereinafter more fully pointed out, include the shifting of the narrowing machine beard pressing cams, shifting of the needle in-and-out motion idling cams to active position, setting of the inner carrier stops, and starting of the racking means for the narrowing point spindles and inner carrier stops to start the formation of the first heel gore.

The right and left beard closing narrowing point units **110**, **112** are racked outwardly simul-

taneously one needle after the knitting of each successive course. The inner carrier stops are racked outwardy two indexes at a time after the knitting of each alternate course so that the carrier will always stand at reversal over a dividing sinker.

The second course of heel fabric in which no knitting takes place on the instep portion of the blank is knitted as shown in Fig. 63, with the traverse of the slur-cock and heel carriers from right to left. As shown in this figure, the points of the beard pressing narrowing point units 110, 112 are still aligned with the needles whose beards they have just pressed in the formation of this course. It will be noted that the innermost narrowing point 110 of the left hand series is aligned with the "2" needle so that a tuck stitch was formed in the "1" or reversing needle having a jack sinker immediately inwardly or to the right thereof. Since there is a dividing sinker immediately inwardly or to the left of the "1'" needle forming the right hand heel, the reversing needle for the right hand heel will be the "2'" needle of that group.

Prior to the formation of the next course, the narrowing point spindle is racked outwardly one index, and the third heel course is then knitted as shown in Fig. 64, the slur-cock and heel carriers being couliered from left to right. Thereafter the heel gore *a* is formed by continued knitting of successively shortened courses, the "1," "3," "5" etc. needles knitting the left hand heel acting as reversing needles of that series, and the "2'," "4'," "6'" etc. needles knitting the right hand heel acting as reversing needles of that series.

At intervals during the knitting of the heel fabrics, needles are added at the outer end of the series to knit the widened courses illustrated particularly in Figs. 45 and 51. In accordance with the invention, two alternative forms of the method have been evolved for producing a firm, easy-to-loop selvage edge of the fabric at the points of widening. It is contemplated that two needles will be added to the knitting series at each widening in order that the yarn carrier at reversal may be placed always over a divider and immediately outside a jack sinker at the point of reversal. For the knitting of a widened selvage edge in accordance with applicant's method, it is assumed that the sinkers and dividers will have substantially the outlines shown in Fig. 85, each sinker 116 within the area in which widening is to take place being provided with a recessed portion 118 in the top edge thereof to permit movement of the yarn carrier across the sinker when in its fully advanced couliered position. The dividers 120 are preferably of the type shown in Fig. 85, and are preferably provided with a sharp point 122 even with the top edge of the divider, although this point may be chamfered without appreciable loss of efficiency in the formation of the selvage. The dividers are also formed with the usual throat 124 and with an additional recess or notch 126 at a lower level. The steps of the method employed are particularly shown in Figs. 69 to 84 inclusive. In these figures, two alternative forms of the method are shown of forming a widened selvage, the position of the yarn taken with one form of the method being shown in full lines, and the position of the yarn with the other form of the method being shown in dot-and-dash lines in such views in which the position of the yarn varies from the full line position of the first method.

In accordance with the form of the method which will be first described, a fabric selvage having the loop formation shown in Figs. 50 and 84 is produced, and the several steps of forming this selvage are illustrated by means of a solid line to illustrate the position of the yarn. In the formation of the widening course, it is assumed that the coulier has taken place from right to left, so that the yarn carrier 108 has stopped in the full line position shown in Fig. 69, over the dividing sinker 130. As the last active jack sinker designated at 132 kinks its yarn 134 in the normal manner around the selvage needle 136, and before the dividers come in, the yarn carrier 108 is shifted outwardly two needle indexes as shown in dot-and-dash lines in Fig. 69. It will be understood that the outward shifting movement of the yarn carrier which extends below the top line of the sinkers is made possible at this time without interference with the sinkers only because of the use of the specially formed sinkers shown in Fig. 85, having formed therein the recess 118. During the subsequent advance of the dividers, divider 130 is caused to kink yarn against the first added empty needle 138 also as shown in dot-and-dash lines in Fig. 69. The kinking of the yarn 134 by divider 130 will cause the needle 138 to take the yarn in its hook as in Figs. 71 and 72, which show the needles at their extreme forward position about to pull the loops off the ends of the sinker noses, and to knock over the same. During the subsequent downward and rearward movement of the needles at the knockover, the yarn 134 will be caught in the recess 126 of divider 130. The position of the yarn as the needles rise subsequent to the knockover is shown in Fig. 73. To attain this position, it is important that the sinker 140 carry forward far enough to lay yarn safely forward of the hook of the rising needle 142. In Figs. 75 and 76 the position of yarn 134 is shown in solid lines, at the completion of the knitting cycle in which the sinkers have been fully retracted and the needles have been raised to their yarn kinking or coulier position. During the return coulier from left to right in the formation of the next succeeding course, the yarn 134, as shown in solid lines in Figs. 77 and 78, will be wrapped about the reversing needle 142, and is kinked by the first active jack sinker 132. In this form of applicant's method, the yarn 134 (see Fig. 78) passes upwardly from the previous reversing loop 144 to the beard side of the first widening needle 138, thence over the nose of the divider 130 to the back side of the reversing needle 142, so that upon the traverse from left to right in the formation of the next succeeding course, the yarn is wrapped around the reversing needle 142, and is then kinked in the usual manner by the first active jack sinker 132. In this form of the method of widening the fabric at the selvage, it is to be noted particularly that the yarn 134 extending from the previous reversing loop 144 passes over the nose of divider 130, and is therefore placed across the shank of the first widening needle 138 substantially above the bottom line of the sinkers, so that in the knitting of the second or reverse course in which the carrier is couliered from left to right, both portions of the yarn 134 held against the beard side of the first widening needle 138 will be caught within the eye of the needle and drawn down, since the point of the needle beard engages its eye at substantially the bottom line of the sinkers to press. For this reason, a true loop is not formed on the

needle 138 in the formation of either the widening or the next reverse couliered course. It will be noted further that the wrap of the yarn about the reversing needle 142 is sufficintly high so that the yarn will be nocated to be received in the usual yarn receiving notch of the divider 130, and will be kinked thereby during the formation of the second or return course with the result that a somewhat objectionable loop 146 is formed as shown, for example, in Figs. 50 and 83 of the drawings.

A preferred form of applicant's method for producing a novel and improved selvage edge of the fabric at the points of the two-needle widenings is illustrated in Fig. 49, and Figs. 69 to 84 inclusive, in connection with the dot-and-dash disclosure of the feeding yarn designated at 150 in such of these figures where the position differs from the full line disclosure of the yarn designated at 134. In this form of the method, the yarn carrier 108 and the several cooperating knitting instrumentalities including the needles are manipulated in such a manner as to cause the first added widening needle 138 to engage within its hook only that portion of the yarn kinked across the beard side thereof during the knitting of the reverse or return course in which the carrier is couliered from left to right while that portion of the yarn extending upwardly from the previous reversing loop 144 is passed over the beard of the needle, and is cast off during the knitting of this reverse course. Further in accordance with this modified form of the method of forming a widened selvage edge, that portion of the yarn 150 extending from the reversing needle 142 during the return coulier from left to right is caused to enter into the lower notched portion 126 of the divider 130 to avoid the extreme kinking and stretching of this wrapped yarn. The selvage edge thus formed as previously pointed out, is shown in Fig. 49 of the drawings. This modified form of the method will be described in connection with the drawings as follows:

In the formation of the first widening course, it is assumed that the coulier has taken place from right to left, so that the yarn carrier 108 has stopped in the full line position shown in Fig. 51 over the divider 130. After the last or active jack sinker designated at 132 is fully advanced to kink the yarn designated at 150 in the normal manner around the selvage needle 136 and before the dividers come in the yarn carrier 108 is shifted outwardly two needle indexes as shown in the dot-and-dash lines in Fig. 69. To this extent the procedure followed is identical with that in the form of the method previously described. In the preferred form of the method about to be described, the needles are caused to move in a novel manner with respect to the other knitting elements to cause the yarn 150, extending from the last reversing loop 144 to the beard side of the first added widening needle 138, to pass under the bottom edge of the divider 130, and thence to the back side of the new reversing needle 142. When this procedure is followed, that portion of the yarn 150 passing from the previously formed loop to the under side of the divider 130 crosses the shank of the first newly added needle 138 at a level sufficiently low as shown in Figs. 76 and 78, so that during the formation of the next course the beard of needle 138 will be closed above this bar of yarn, causing the same to be cast off and forming a true loop on the first added needle in this second reverse course immediately following the first widening course. It will be noted further that the wrap of the yarn about the newly added selvage needle 142 is at a lower level than is the case with the yarn 134 positioned in accordance with a previously described form of the method, so that during the knitting of the next succeeding course in which the yarn carrier 108 moves in the reverse direction from left to right, the yarn 150 is positioned with respect to the divider 130 at a lower level than was the case with the yarn 134 in accordance with the previously described method, so that the yarn 150 will enter the notch 126 of the divider 130 (see Figs. 78 and 85) instead of in the usual throat 124. The positioning of the yarn in the notch 126 has the effect that the yarn is not kinked and is therefore not stretched by the divider 130 during the reverse coulier stroke of the yarn carrier 108 in forming the second or return knitted course.

Manipulation of the machine to cause the yarn 150 to be laid in this relatively low position with respect to the knitting instrumentalities during this selvage widening operation is as follows: After the yarn carrier 108 has been stepped outwardly two indexes as above set forth, the machine is permitted to turn over until the dividers have been brought in and the needles have moved downwardly almost to the knock-over level so that the loops are just being drawn off the noses of the sinkers. At this position which is the position shown particularly in Fig. 86, the needle bars are rocked forward slightly so that the yarn 150 extending to the yarn carrier 108 from the last reverse loop 144 now positioned at the extreme upper end of the needle hook, is caused to snap off of and under the end of the nose of divider 130. The needle bars are then again rocked inwardly to their normal position, the parts at this time being in the position shown in Fig. 72. As the operation of the machine continues, the needles move to the knockover position and thence inwardly toward the press position as shown in Fig. 73 and in Fig. 74, where the yarn 150 is shown as passing beneath the divider 130.

During the formation of the next succeeding course in which the yarn carrier 108 moves from left to right, the yarn 150 is wrapped around the reversing needle 142 at a relatively low level in a position to pass into the notched portion 126 of divider 130, and is kinked in the usual manner by the first active jack sinker 132. For the knitting of this second widened selvage course, the knitting instrumentalities operate in the normal manner. At the end of the coulier after the sinkers are all forward, the dividers are advanced to reform the yarn kinks against all the needles. The yarn 150, having been laid in an abnormally low position with respect to the divider 130 as above set forth, passes into the notch 126 and is not kinked by the divider 130 during the advancing movement of the same, so that any tendency toward looseness of the yarn forming the reversing or selvage loop to be held on the selvage needle is avoided. The needles now move downwardly and rearwardly to press following the usual pattern of operation of these elements, in accordance with which the beards are closed when the tips of the beards are slightly above the bottom line of the sinkers. The beards close therefore when the tips are below the level of the newly kinked yarn and above the level of the previously formed fabric loops held on the shanks of the needles. This pressing operation

has the effect of enclosing the wrap about the newly added selvage needle 142 under the needle beard. The beard of the inner of the two added needles 138 closes over the newly kinked yarn but above that portion left during the knitting of the previous widening course below the bottom line of the sinkers as a result of the passing of this yarn beneath the divider 130. As the needles now continue their downward movement to the knockover level, the bar of yarn crossing the shank of the first added needle 138 is cast off and a true loop is formed by this needle during the knitting of this second or reverse course.

In accordance with the preferred form of the invention, a novel method is provided for varying the length of successively knitted courses of the heel gore by one loop at a time and without tucking to form the inner or suture edge thereof on the conventional Cotton type full-fashioned hosiery machine having alternating sinkers and dividers and a yarn carrier system adapted for stopping the traverse of any carrier over a divider only. The structure of the fabic produced in accordance with this preferred form of the method has been previously described and is illustrated in Fig. 47 of the drawings. The steps of this form of the method for forming the inner or suture edge of the heel gores will be readily understood in connetcion with Figs. 34, 35, 36 and 86 of the drawings. In the knitting of the first heel course as shown in Fig. 34, the yarn carrier designated at 154 is stopped at the end of its left to right traverse over divider 156 so that no yarn is fed to the number one needle, and yarn is fed in the normal manner to the number two needle. As shown in Fig. 34, the beards of the active needles of the outwardly disposed series numbered 2, 3, etc. of the group engaged in the knitting of the heel gore, have been engaged and pressed by the beard covering narrowing points, while the number one needle is permitted to retain its loop. After the needles have pressed and when the sinkers have been retracted to about the position shown in Fig. 86, the machine is stopped and the yarn carrier 154 is shifted outwardly or to the left two indexes to the position shown in Fig. 35, where the carrier is shown over the next outwardly disposed divider 158, the yarn leading downwardly from the carrier to the loop of yarn 160 which has been formed on the number two needle. The yarn carrier is now in a position to lay the yarn over the noses of the divider 158 and the next outwardly disposed jack sinker 162 upon the next or reverse coulier stroke from right to left of the yarn carrier 154 so that the yarn from carrier 154 will be caused to be kinked first around the number three needle in the formation of this next course. In the next following course in which traverse of the carriers is from left to right, the carrier will stop over the divider 158 so that the terminal loop of said third course will be located on the number four needle, and as the yarn carrier is again transferred two indexes prior to the return stroke, the terminal wale loop of the next succeeding or fourth heel course will have its terminal loop on the number five needle.

Further in accordance with applicant's novel method of knitting the shaped heel of a combination foot and leg hosiery blank in accordance with the invention, a novel and improved procedure is employed for the knitting of a first long course of a heel fabric gore following the completion of the last short course of a previous fabric heel gore. In this specific case, where the last knitted course of the previously formed heel gore was knitted on a small group of heel needles toward the outer ends of the needle series with the beard pressing narrowing points racked correspondingly outwardly and with a substantial number of the heel needles inwardly considered adjoining the instep needles having been rendered inactive, the knitting of the first long course of the next heel gore requires that a substantial number of the previously idled needles be added to the active group of heel needles inwardly toward the instep portion of the needle series. In order to carry out this operation, it is required to move the beard pressing narrowing point units inwardly a large number of indexes subsequent to the completion of the last short course of the previous gore and prior to the knitting of the first long course of the new heel gore. In the preferred form of applicant's method, it is proposed to move the left and right heel beard pressing narrowing point units inwardly simultaneously, and to employ the usual point indexing spindle for this purpose. Inasmuch as the operation of the carriers is not similarly symmetrical, and the knitting of a first course of heel gore fabric during the traverse of the slur-cock from left to right is effective to form a true first course only on the left hand heel, the first true heel fabric course for the right hand heel being formed during the subsequent traverse from right to left, an important step of applicant's improved procedure consists in the manipulation of the carrier to cause knitting to take place properly during the knitting of the first course to avoid casting off of loops or other difficulty which might arise through the premature moving in of the right hand heel group of beard pressing narrowing points. Specifically, in accordance with the improved procedure here set forth, it is proposed to so manipulate the carriers and carrier stop mechanisms as to provide for the knitting of a first long heel course on the right hand group of heel needles simultaneously with the knitting of the first long course on the left hand group of heel needles during the traverse from left to right, and at the same time to provide such a connection with the idled inwardly extending heel and instep needles as to insure a firm and tightly woven fabric about the inner tip of the gore and to avoid the formation of objectionable eyelet holes.

The details of the procedure followed are specifically set forth in a series of diagrammatic views Figs. 65 to 68 inclusive, of the drawings. In Fig. 65, the beard pressing narrowing points are shown in the position assumed at the completion of the knitting of the last narrowed course of heel fabric formed in the knitting of the first heel gore, the needles having pressed and drawn down the new loops, and the beard pressing narrowing points being shown clear of the needles. The innermost narrowing points of the two groups of heel beard pressing narrowing points are shown opposite the 48 and 48′ needles respectively. For the knitting of the next or first long heel course for the formation of the next succeeding gore, it is proposed to add inactive needles inwardly of the active heel needle series to include needle 9 in the left hand heel series, which because of the location of a jack sinker inwardly thereof will be the first reversing needle of the new series, and on the right hand needle series the 10′ needle which will be the first reversing needle by virtue of the position of a jack sinker immediately inwardly thereof.

The first step of this operation in accordance

with applicant's improved procedure consists in the relocation of the inner carrier stop for the right hand heel. During the knitting of the next to last course of the preceding gore in which the coulier takes place from left to right, the inner carrier stop for the right hand heel carrier is shifted inwardly so that during the subsequent traverse from right to left, yarn will be fed to needle 8'. Fig. 65 shows the positions of the parts for the completion of the last short course of heel fabric in the knitting of the first heel gore. It will be noted that the right hand heel carrier **104** has moved inwardly against its stop located as above noted, so that it stands over the divider between the 6' and 7' needles in a position to feed yarn to the 8' needle having a sinker disposed inwardly thereof. Since in the knitting of this last short heel course of the previous gore, there are no beard pressing points opposite the 8' to 47' needles so that these needles do not press, a float of yarn will be formed except that with respect to the last of the added needles, that is, needle 8', the yarn will be located to the back side of the needle by the action of the sinker disposed between the 8' and 7' needles. The manner in which the yarn is laid as shown in Fig. 65, will be clear from a consideration of Fig. 73, for example, in which the yarn is similarly located to the back side of an end needle.

Prior to the knitting of the next or first long heel course of the next heel gore, the two groups of heel knitting beard pressing narrowing points are moved rapidly inwardly so that the innermost points of the two series are opposite respectively to 8 and 8' needles as shown in dotted lines in Fig. 66. The point spindle is then racked one index prior to the pressing of the needle beards, so that the innermost points are located respectively opposite the 9 and 9' needles, this outward racking having the effect of properly registering the points with the needles. Fig. 66 specifically shows the position of the parts at the completion of the first long course of the new heel gore in which the left hand heel carrier **102** has completed its traverse from left to right feeding yarn to reversing needle 9. Simultaneously the traverse of the right hand heel carrier **104** from left to right has caused the yarn to be wrapped about needle 8' and the first loop to be formed on needle 9'. During the knitting of the second heel course in the traverse from right to left, the narrowing point spindle is again racked to move the points outwardly one index so that a reversing loop is left on the now inactive 9 needle, and a loop is formed in a normal manner on the 10 needle. During this traverse from right to left, the right hand heel carrier **104** will have moved inwardly to feed yarn to the 10' needle which will then become the first reversing needle in the formation of the second right hand heel gore. From this point on the knitting of the gore proceeds in the normal manner as previously set forth. The same procedure will be again followed in the knitting of the long course of each successively formed gore until the heel is fully knitted.

In accordance with the present invention, it is contemplated that an alternative procedure may be followed if so desired for the knitting of that portion of the heel which includes the knitting of a first long course of a left hand heel gore following the knitting of the last short course of a preceding gore out of step with the knitting of the first long course of the right hand heel gore. The procedure which it is proposed to follow in this alternative form of applicant's method includes the inward movement of one narrowing point unit and operation of said unit in the inner position one course in advance of the inward movement and inward operation of the other narrowing point unit. This procedure will be particularly described in connection with diagrammatic Figs. 30, 31 and 32 of the drawings, in which the heel needles are indicated as open circles, and the instep needles are indicated as solid black discs. The right heel yarn carrier **104** is shown in Fig. 30 at the inner end of its stroke prior to the knitting of the last short course of the previously knit heel gore for the right hand heel. This view shows the last short knitted course for the left hand heel. The yarn laid by the right hand heel carrier is designated diagrammatically at **166**, and the yarn laid by the left hand heel carrier **102** in the knitting of this course is designated at **168**. The beard covering narrowing points cooperating with the needles knitting the left hand heel are designated as in previous views at **110**, and the beard covering narrowing points of the group associated with the needles for the knitting of the right hand heel are designated at **112**. The position of the parts in Fig. 30, is assumed to be that which would be taken upon the completion of the knitting of the last course when the yarn designated by the lines **166** and **168** has been formed into loops, and the beard covering narrowing points have again moved away from the needles. Prior to the knitting of the next course with the coulier from left to right which will be the first course in the knitting of the new heel gore, the group of narrowing points **110** is moved inwardly so that the innermost point will cover needle 9, and the left hand heel inner carrier stop is adjusted so that during this traverse from left to right in the knitting of this course, the left hand heel carrier **102** will stop over a divider located between the 8th and 7th needles to feed yarn to the 9th or first reversing needle of the new gore. In this form of the method, the narrowing points **112** of the group associated with the needles knitting the right hand heel are permitted to be stepped outwardly again one index to form one additional short course in the right hand heel. The construction and arrangement of the mechanism and manual controls for shifting the narrowing points **110** of the left hand group inwardly one course prior to the similar inward movement of the narrowing points **112** of the right hand group, will hereinafter be more fully set forth. For purposes of illustration of the method, it may be stated that the narrowing point supporting bar for supporting the group of narrowing points **110** associated with the left hand heel needle group is moved inwardly away from its normal contact with the stop abutment forming part of the left hand narrowing point control nut mounted on the narrowing machine racking spindle, and is then latched in its inner position by means of a manually operable latch lever. Prior to the knitting of the second heel course of the new gore with a coulier from right to left, the narrowing point spindle is rotated to shift the narrowing spindle nuts rapidly inwardly, so that the innermost narrowing point **112** of the right hand series is positioned over the 9' needle, and the spindle is then racked one index outwardly so that the first needle covered by the innermost narrowing point of the right hand series will be the 10' needle. At the same time the latch above referred to holding the points **110** of the left hand series is released so that these points may be similarly shifted outwardly one index to uncover needle 9.

Fig. 32 shows the position at the completion of the knitting of the second course in the formation of the new heel gore in which two courses of heel fabric forming the new gore have been knitted as to the left hand heel, and one such course has been knitted in the formation of the right hand heel.

The procedure above described may be employed also for the knitting of the first course of the first gore for the left hand heel one course in advance of the knitting of the first course of the first gore for the right hand heel. For the knitting of the first course for the left hand heel the left narrowing point unit is brought in while the right hand unit remains in an inoperative position beyond the active needle range.

The machine disclosed in the drawings as embodying in a preferred form the several features of the present invention, is a multiple section full-fashioned Cotton type machine such as is ordinarily employed for the knitting of the leg and heel portion of a full-fashioned stocking blank. While a multiple section machine is particularly described and illustrated, it will be understood that the invention is not limited in its application to a multiple section machine, but may be equally applicable to other types of knitting machines including single section machines having the usual arrangement of needles movable en masse with relation to a press edge, a slur-cock mechanism, jack sinkers which are successively advanced in a knitting wave to keep the yarn against the needle shanks, dividers alternating with the sinkers which are subsequently advanced to re-measure the yarn against the needle shanks, knockover bits cooperating with the needles and sinkers for the knocking over of the previously formed loops upon downward movement of the needles, a narrowing machine including groups of narrowing points which are arranged to be shifted or indexed along the needle series, traversing yarn carriers, and carrier stops adjusted in such a manner as to control the operation of the yarn carriers for feeding the yarn to active needles.

Each knitting section of the machine consists of a needle bar 170 containing spring beard needles 172 having an up-and-down movement for drawing down and knocking over the loops of fabric, and an in-and-out movement toward and away from the fixed pressing surface 174 to press and to cast off the old loops of yarn, together with individually movable yarn measuring sinkers 176, alternating dividers 178, and knockover bits 180 which cooperate with the needles to knock over the loops and to support the fabric with relation to the needles. The supporting structure of the machine comprises a series of frames 182 spaced every two knitting sections along the length of the machine, which are rigidly held together by the stiffening rails 184, 186, 188 and the usual work table 190.

The frames 182 have formed therein bearings for the several operating shafts which for the most part extend along the length of the machine and include particularly the cam shaft 192, the needle bar shaft 194, the presser shaft 196, the knockover bit shaft 198, the narrowing machine lifting shaft 200, the narrowing machine fulcrum shaft 202, the narrowing racking screw shaft 470, the narrowing point unit fulcrum shaft 206 and the fabric take-up shaft 208 (see Fig. 1).

In carrying out the present invention, a novel and improved arrangement and cooperation of the several knitting instrumentalities of a Cotton type knitting machine is employed in order to permit the terminal wale loops of the instep fabric to be held on the shanks of the instep needles in an inactive position while knitting is continued on a variable number of heel needles for the knitting of the shaped heel fabric. For this purpose, the knitting motion of the needles is somewhat modified to permit the needles to go through the cycle of their knitting motion without, however, coming into engagement with the press edge, so that the loops held on the instep and other inactive needles will not be pressed off, and the narrowing point units are caused to cooperate with the needles in such a manner as to press the beards of selected groups of active heel needles so that knitting will take place on those needles only. In order to avoid stretching or severing of the loops held on the inactive needles as the result of the continued needle motion during the knitting of the relatively large number of heel courses, a special form of knockover bit is employed, and improvement has been made in the supporting and actuating means for the knockover bits to substantially reduce the strain and wear on the held loops on the needle shanks.

In accordance with the usual practice, the needle bar 170 is pivotally supported on horizontal needle bar supporting arms 210 secured to the needle bar shaft 194 of the needle up-and-down motion which in turn has secured thereto downwardly extending cam levers 212 with cam engaging rollers 214. A heavy spring indicated at 216' secured to the lower end of cam lever 212 tends to move the cam lever 212 and roller 214 rearwardly against its cam. The needle press motion comprises the usual downwardly extending arm 216 of the needle bar 170 which is connected by means of a cross link 218 with a downwardly extending arm 220 on the presser shaft 196. Downwardly extending cam levers 222 secured to the presser shaft 196 have supported thereon cam rollers 224 for engagement with any one of a bank of cams on the cam shaft. A heavy spring 226 secured to a downwardly extending tail of the cam lever 222 tends to move the cam lever 222 and follower roll 224 rearwardly to maintain engagement of the roll with its cam.

The narrowing machine illustrated in the drawings, comprises the front narrowing machine shaft 206, the rear narrowing machine fulcrum shaft 202 and supporting arms 228 which connect the two shafts at intervals along the length of the machine and are rigidly secured to the fulcrum shaft 202. In accordance with the usual construction, the narrowing machine shaft 206 has rigidly secured thereto a series of downwardly extending brackets 230 in which are received the usual axially slidable narrowing point unit supporting bars 232, 234, of which the upper bar 232 provides support for a right hand narrowing point unit 236 at each knitting section of the machine, and the bar 234 provides support for a left hand narrowing point unit 238 for each knitting section. Each unit with the present construction is assumed to comprise a group of 56 narrowing points 239. The narrowing machine is supported and is moved vertically about the pivot provided by the rear narrowing machine fulcrum shaft 202 by means of a link 240 pivotally connected at its upper end to the shaft 206 and at its lower end to a horizontally disposed cam lever 242 which is pivotally supported at its forward end on a stud 244 on one of the machine frames 182. A follower cam roller 246 slidably supported

on a stud 248 on the cam lever 242 is arranged to engage alternatively with any one of a number of narrowing machine operating cams which include an idle cam 250, the usual narrowing cam 252 and a narrowing machine point covering knitting cam 254. The cam roller 246 is arranged to be shifted axially on its stud by means of a shifting fork 256 carried on an axially movable pattern shift rod 258.

Since the entire weight of the narrowing machine is carried on the supporting connections above described including the cam follower roller 246, mechanism is provided in machines of this description for raising the narrowing machine prior to the shift of the follower 246 from one to another of the narrowing machine cams. In accordance with the embodiment of the present invention, a novel lift mechanism is employed, this mechanism being generally shown in Figs. 1 and 4 of the drawings, and includes a narrowing machine lift cam lever 260 secured to the rotatable narrowing lift shaft 200, the follower roll 262 supported for axial shifting on a stud 264 on the lift cam lever 260, a lift cam 266 on the main cam shaft 192, rearwardly extending lever arm 268 secured to the narrowing machine lift rock shaft 200, and an upwardly extending link 270 pivoted thereon and arranged at its upper end for engagement with the notched rear end of the narrowing machine vertical motion cam lever 242. In order to control the position of the upwardly extending link 270, a spring 272 is arranged to urge the link forwardly against an adjustable stop 274 on an arm 276 on the narrowing machine lift rock shaft 200. The lift cam lever 260 and lift shaft 200 are urged in a counterclockwise direction by a heavy spring 278, this movement being limited by engagement of an adjustable stop 280 on a downwardly extending arm of the lift shaft 200 with an abutment 282 on the machine. The narrowing machine lift follower roll 262 is shifted into and out of operative relation to lift cam 266 by means of a shifting fork 284 and an axially movable pattern shift rod 286.

In accordance with the invention, a novel mechanism is employed for shifting the narrowing machine operating cam roller onto its knitting or beard closing cam. The mechanism provided is arranged to be controlled from the pattern chain of the machine, and acts independently of the usual narrowing machine control mechanism which is thrown into operation by a shogging of the cam shaft of the machine rightwardly to a narrowing position. The mechanism for shifting the narrowing machine cam roller to the knitting or beard closing position comprises means for biasing or tensioning the narrowing machine operating cam roller rightwardly through the operation of one pattern chain actuated shift connection, and an additional control from the pattern chain for shifting the narrowing machine lift cam roller 266 onto its operating cam 262 to raise the narrowing machine so that the operating cam roller is unweighted from its idle position cam and is permitted to move under the influence of the biasing means to the knitting or beard closing position. As shown in Fig. 10, a shift cam lever 288 is mounted to turn on a fixed pivot 290, and has formed therein a cam track 292 in which is engaged a pin 294 on a bracket 296 secured to the pattern shift rod 258. The position of the cam lever 288 is controlled by means of a downwardly extending operating lever 298 which is arranged to be acted upon by a collar 291 on a pattern chain actuated shift rod 293 and is formed adjacent its upper end with a laterally extending offset which carries an adjustable stop 300 for engagement with the cam lever 288. A tension spring 302 extending between the cam lever 288 and the offset of lever 298 acts to move the cam lever downwardly to maintain the same in engagement with the stop 300. The entire assembly including the lever 298 and cam lever 288 is urged in a clockwise direction by means of a tension spring 304 connected with the end of the lever 298. Movement of shift rod 293 to the right when actuated by a bump on the pattern chain rocks the lever 298 counterclockwise and tensions the spring 302 and cam lever 288 so that the pattern shift rod 258 for the narrowing machine operating cam roller or rollers 246 is biased toward the knitting or beard closing position.

The shift rod 258 for controlling the operation of the narrowing machine to cause the narrowing points to close the needle beards in accordance with a knitting cycle is held in its shifted position to maintain the several narrowing machine cam rollers in engagement with their knitting cams during the entire extent of the heel knitting by means of a latch 295 carried on a stationary pivot 297 and yieldably urged by a spring 299 in a direction to engage behind a collar 301 on the shift rod 293. At the end of the heel knitting operation, the latch is automatically tripped by the pattern chain of the machine through connections including a link 303 and a pattern chain actuated lever (not specifically illustrated), since these parts are of ordinary description.

In accordance with the invention, the narrowing machine of the illustrated construction is constructed and arranged to permit the narrowing point units to be rocked rearwardly to an alternative position somewhat closer to the press edge than normal to cooperate with the needles in a beard pressing capacity for the knitting of the shaped heel fabrics. To this end the front narrowing machine shaft 206 is supported for rocking movement in bearings formed in the supporting arms 228, and has rigidly connected thereto a rocking shift control lever arm 324 (see Figs. 1, 2 and 3) bifurcated at its free end to receive two pairs of opposed cam engaging screw stops 326. A cam sleeve 328 mounted for axial movement on the narrowing machine fulcrum shaft 202 has formed thereon stepped cam surfaces 330 which engage the screw stops 326 and act upon axial movement of the cam sleeve 328 to rock the narrowing point shaft 206 and narrowing point units 236, 238, from one to the other position. Laterally extending hook-shaped extensions 332 of the bifurcated portion of the rocking shift control lever arm 324 are arranged to extend into the path of movement of the cam sleeve 328 and limit movement of the sleeve in each direction. The shift of the cam sleeve 328 and point fingers controlled thereby is effected by the pattern chain 315 of the machine simultaneously with the shift of the narrowing machine operating cam roller to the knitting position (Figs. 1 and 10) through connections comprising an axially movable control rod 334 supported parallel to the narrowing machine fulcrum shaft 202 and secured to an ear on the cam sleeve, a lever 336 supported intermediate its length on a pivot pin 338, and the pattern chain control shift rod 258. The lever 336 at its upper end is arranged to act against a spring 340 seated against a collar 342 on the control rod

334 (Figs. 1, 2 and 3), and at its lower end engages against a collar 344 on the pattern shift rod 258.

The operation of the pattern controlled shift rod 258 to shift and to maintain the narrowing motion cam followers 246 in engagement with the narrowing machine heel knitting cams 254 during the knitting of the heel fabric has been described. It will be evident that the shifting of pattern rod 258 to the heel knitting position will act at the same time through lever 336, control rod 334 and cam sleeve 328 to rock the narrowing point fingers rearwardly to their beard pressing position for the knitting of the first and subsequent heel courses. The return of the pattern rod 258 and cam followers 246 to their inactive position subsequent to the knitting of the last heel course will cause the narrowing point fingers simultaneously to be rocked to their normal narrowing positions.

In accordance with the invention, a modified needle motion is employed for the knitting of the heel fabric to cause the needles to cooperate with the beard pressing narrowing points to form loops on the heel needles without, however, engaging the beards of the instep and any idled needles against the regular press edge 174, so that these idled needles are permitted to retain their loops. The modified needle motion makes use of the regular up-and-down needle motion cam 346 (see Figs. 1 and 4). The in-and-out needle motion cams include the usual knitting cam 348, the usual narrowing cam 350 and a special in-and-out needle motion cam 352 mounted to the right of the regular cam as shown in Fig. 4. This cam duplicates the usual needle motion, except that the needles at the press are not moved rearwardly a sufficient distance to engage their beards with the press edge 174. The press movement, however, is sufficient to cause the heel needles to cooperate with the beard pressing narrowing points to properly close the beards of the active heel needles. In order that the heel in-and-out needle motion knitting cam 352 may be rendered operative for the knitting of the heel courses, the roller 224 is supported for axial movement on its stud 354 on the cam lever 222. A shifting fork 356 supported on a pattern shift rod 358 engages the sleeve hub of the cam roller 324 for shifting the roller from one to the other of its cams. The pattern shift rod 358 for controlling the position of the needle in-and-out motion cam roller or rollers 224 is retained in its shifted heel knitting position throughout the knitting of the heel fabric by means of a latch 306 (see Fig. 10) pivotally supported on a fixed bracket 308 and arranged for engagement with a stop collar 310 on the pattern shift rod 258 to lock the shift rod 258 in its shifted position which is to the right of that shown in Fig. 10. A tension spring 312 connected to a downwardly extending arm 314 of the latch tends to move the latch to its engaging position. At the completion of the knitting of the heel fabrics, the latch 306 is automatically disengaged to permit the shift rod 258 to return to the normal position shown in Fig. 10, and thus to return the needle in-and-out motion cam follower roller or rollers 224 to the normal knitting position. The release of the latch 306 is effected by connections including a link 316 connected at one end to the arm 314 of latch 306 and at its other end to one arm of a pattern chain lever 318 supported on a transverse pivot 320 and arranged for engagement with a bump such as that designated at 322 on the pattern chain.

During the knitting of a widened selvage in accordance with a preferred form of the present invention, the heel yarn carrier stops over the usual selvage divider, and is thereafter moved two needles outwardly as the dividers come in (see Fig. 69) in order to cause the yarn to be placed to the beard side of the first added needle and to be wrapped around the shank of the outwardly disposed added needle upon the return stroke of the yarn carrier. As hereinafter more fully set forth, outward movement of the heel yarn carrier for widening is automatically effected by the outward racking of the outer carrier stops at this point in the knitting cycle, and the carriers are moved outwardly with the stops owing to the fact that this outward shift takes place prior to the completion of the draw stroke of the slur-cock mechanism. In accordance with a preferred form of applicant's method, the needles, as they move downwardly, are rocked outward slightly away from the noses of the sinkers at about the position shown in Fig. 86 so that the additional outward traverse of the heel yarn carrier will cause the newly laid increment of yarn to be placed wholly beneath the next outwardly disposed divider, and will further cause the yarn to be wrapped at an abnormally low level around the more outwardly disposed selvage needle. In order to effect the abnormal outward movement of the needles away from the press during widening operations in heel knitting, the needle heel knitting in-and-out or press motion cam 352 is provided with a dip or cutaway portion which is effective to allow the needle to fall outwardly away from the press a slightly abnormal amount at the point in the knitting cycle when the needles are drawing their loops off of the noses of the sinkers. This dip is indicated at 351 on the needle in-and-out motion cam 352 as shown in Fig. 33 of the drawings. This abnormal outward movement of the needles is permitted only during the widening operation above referred to, the in-and-out motion cam roller 224 being at all other times during heel knitting prevented from moving inwardly into the dip 351. The mechanism for controlling the in-and-out motion of the needles to cause them to follow either a normal or abnormal course of movement as the loops are drawn from the sinker noses during heel knitting, comprises a lever 353 secured to the needle presser shaft 196 of the machine, and arranged for engagement with a sleeve 355 slidably supported upon the hand wheel shaft 357 of the machine (see particularly Fig. 1). The sleeve 355 is movable into and out of operative position directly beneath the forwardly extending tip of the lever 353. The lever 353 is arranged closely but not touching the sleeve 355, and in this position does not interfere with the stitch adjustment of the needle presser motion. The lever 353 is adjusted so that it just touches the outward diameter of the sleeve 355 when the needle presser motion roller 224 is in the normal inwardly disposed position corresponding with the first knockover position of the needles. When the sleeve 355 is moved axially along the hand wheel shaft 357 out of alignment with the lever 353, the lever is then free to move downwardly in a clockwise direction so that the in-and-out or presser motion cam roller 224 is permitted to ride to the bottom of the dip portion 351 of its heel knitting cam, thus imparting thereto the abnormal needle rocking-out motion necessary for the knitting of the selvage edge in accordance with the preferred form of applicant's method.

The position of the sleeve 355 is controlled automatically from the pattern chain of the machine through connections which, as best shown in Fig. 1, comprises a pattern shaft rod 359 to which is secured a vertically extending sleeve extension 359' which engages with a downwardly extending lug on the sleeve 355. The sleeve extension 359' is slidably supported on two other shift rods of the series merely in order to provide a stiffer construction.

Further in accordance with the invention, the knocking-over elements with the present construction are supported and arranged to operate in a novel and improved manner in relation to the several cooperating knitting instrumentalities of the machine for the performance of each of the several knitting and other operations the knitting instrumentalities are called upon to perform. As best shown in Figs. 1, 19 and 20 of the drawings, the knockover bits 180 employed in this present construction, are of the so-called notched or nib type having formed therein the throat 360 for holding down the fabric during the rising movement of the needles. The knockover bits are mounted in a slotted knockover bit bar 362 having a cover plate 364. The bar is provided at each end thereof with downwardly extending arms 366 which have a pin and slot connection with horizontally disposed lever arms 368 secured to the knockover bit shaft 198. Adjacent their upper ends the arms 366 are supported for vertical and limited horizontal movement in slots formed in brackets 370 which are closed in by a cover plate 372. Tension springs 374 connected between the knockover bit bar 362 and stationary forwardly extending brackets 376 act to support the knockover bit bar 362 and bits 180 yieldingly in the fully advanced or projecting position (see Figs. 19 and 20). The knockover bit bar is urged yieldingly upwardly by means of tension springs 378 (see Fig. 1) connected at their upper ends to pins 380 on a fixed portion of the machine, and at their lower ends carried on the vertical supporting posts 366 for the knockover bits. Upward movement of the arms 366 and knockover bit bar 362 is limited by engagement of stop screws 379 threaded into the lower ends of arms 366 and slots 381, with the associated pins 383 on the supporting arms 368. For imparting the usual vertical positioning movements to the knockover bits, spring-seated as above described, the knockover bit shaft 198 has secured thereto one or more downwardly extending cam levers 382 each of which carries a cam follower roller 384 for engagement with the usual knockover bit lift motion cam 386. A tension spring 388 connected at one end to the lower end of the cam lever 382 and at its other end to a point on the machine frame, acts to maintain the roller 384 against its cam.

A feature of the invention consists in the provision of a novel control mechanism which acts during each knitting cycle of the machine to maintain the knockover bit in a relatively retracted position horizontally during a major portion of the knitting cycle, and permits the knockover bits to be moved forwardly under the influence of their tension springs 374 only at that point in the knitting cycle at which the needles move rearwardly and start to rise from the knockover level. This mechanism, as best shown in Figs. 1, 10, 18, 19 and 20, comprises a rod or bar 390 which extends along the length of the machine, being supported for axial movement in brackets 392 on the work table 190. Opposite each end of each knitting section there is secured to the bar 390, a rearwardly extending support 394 to which is secured a cam plate 396. Clamping screws 398 extending through slots formed in the cam plate 396 provide means for adjustably securing the cam plates 396 to their supports 394. A cooperating follower element 400 in the form of a forwardly extending plate with a pointed end is secured to each end of each knockover bit bar 362 for engagement with the stepped cam which forms the rearward edge of the cam plate 396. With this construction and arrangement of the parts, movement of the cam bar 390 axially to the right along the length of the machine, will cause the follower 400 to ride onto the low portion of its cam, thus permitting the knockover bits to be tensioned forwardly under the influence of their springs 374. Movement of the cam bar 390 leftwardly to the position shown, for example, in Fig. 20, will cause the knockover bits to be moved rearwardly against the pressure of their springs 374 to a relatively retracted position.

During the operation of the machine for ordinary knitting, and also during the knitting of the shaped heel portions of the stocking blank, the cam bar 390 is actuated through connections from the cam shaft of the machine to cause the knockover bits to be held normally in their fully retracted or rearward position, and to move forwardly to engage the nib portion thereof in the previously formed fabric loops only as the needles move rearwardly and start to rise from the knockover level. This mechanism comprises a bell-crank lever 402 (see Fig. 10) supported to turn on a pivot pin 404. A horizontal arm of the lever 402 extends parallel with the cam bar 390 and is provided with a cammed outer end 406 for engagement with a stop pin 408 on the cam bar 390. A downwardly extending arm of the lever 402 is urged into engagement with a face cam 410 on a disk 412 on the cam shaft by a tension spring 413. A spring 414 (see Fig. 10) connected at one end to a pin on the cam bar 390 and at its other end to a bracket on the table 190 acts to urge the cam bar 390 to the left to maintain the pin 408 in engagement with the cammed end 406 of the lever 402.

Further in accordance with the invention, the knockover bits are arranged to cooperate in a novel and improved manner with the several knitting instrumentalities during a narrowing cycle of operation of the machine. At the beginning of the narrowing cycle of operation, the webholders are caused to move to their fully advanced position under the influence of their springs 374, and are maintained continuously in this position until just prior to the final withdrawing movement of the narrowing points at the end of the narrowing cycle. The mechanism for controlling the forward and back position of the knockover bits 180, particularly during the narrowing operation, comprises an actuating lever 416 (see Fig. 10) which is rendered operative by the axial shifting of the main cam shaft 192 to the narrowing position to the right to rock the bell-crank lever 402 in a clockwise direction to shift the cam bar 390 and cam plates 396 to the right, and thereby to permit the webholders 189 to be moved yieldingly to their advanced or forward position. The lever 416 is supported intermediate its length on a stationary bracket 418, and is provided at its lower end with an engaging sur-

face which is arranged to be acted upon by the cam disk 412 on the cam shaft as the cam shaft is shifted to the right to the narrowing position. The rocking movement thus imparted to the lever 416 causes the upper end thereof to engage with and act upon a pin 420 on the bell-crank lever 402 to rock the same in the clockwise direction. A small tension spring 422 connected between the lever 416 and a stationary bracket 424 tends to rock the lever 416 in a clockwise direction away from the pin 420 to a position determined by the engagement of a stop screw 426 on the level with the bracket 424. The return movement of the cam shaft 192 and disk 412 to the left slightly before the end of the narrowing operation, causes the bell-crank lever 402 to be again rocked in a counterclockwise direction under the influence of its spring 413 to again shift the knockover bits 180 to their retracted position as the follower 400 rides onto the high portion of the cam surface of the plate 396.

In accordance with the invention, mechanism is provided for releasing the take-up tension on the fabric during the knitting of the heel fabrics. As best shown in Figs. 1, 5 and 10 of the drawings, the machine is provided with the usual take-up mechanism comprising a take-up roll shaft 208 which extends along the length of the machine at the front side of the work table 190, and provides support for the usual wind-up rolls 432 at each knitting section. A take-up tensioning strain is imparted to the shaft 208 by means of connections which comprise a pulley 434 which is loose on the shaft 208 and is connected to turn therewith by means of a pawl 436 pivoted on the pulley 434 and arranged for engagement with a ratchet 438 secured to the shaft 208. A cord 440 wound about the pulley 434 extends upwardly over idler pulleys (not shown) to the rear side of the machine, and is weighted in the usual manner. The mechanism herein provided for relieving the tension on the fabrics applied by the take-up mechanism above described, comprises a ratchet 442 which is secured to the take-up roll shaft 208 and is arranged to be acted upon by the pawl 444 carried on a bell-crank lever 446 loosely supported to turn on the take-up roll shaft 208 adjacent the ratchet. A pin 448 on the pawl 444 is arranged for a fully retracted position of the pawl and bell-crank shown in Fig. 4, to ride on a fixed shield 450 provided for that purpose. The pawl 444 engages the ratchet 442 only when the supporting bell-crank lever 446 is rotated about the shaft 208 sufficiently for the pin 448 to clear the shield 450. The horizontally extending arm of the bell-crank 446 is connected by means of a link 452 with one arm of a bell-crank pattern controlled lever 454 supported to turn on a fixed bracket 456. A downwardly extending arm of the lever 454 is arranged to be engaged by a collar 458 on the pattern shift rad 358. Movement of the shift rod 358 to the right as above described, at the beginning of the heel knitting operation, acts to rock the bell-crank 446 to engage the pawl 444 with the ratchet 442, and thus to rock the take-up shaft 208 in a direction to release the tension on the fabric against the biasing strain of the weighted take-up cord 440. The tension is thus removed from the fabric during the entire knitting of the heel fabrics, and the fabric is again tensioned only when the pattern rod 358 is permitted to return to its inactive position to the left upon the completion of the heel fabrics.

The operation of the knitting instrumentalities including the needles, sinkers, dividers, knockover bits and beard covering narrowing points for the performance of each of the several operations in their several cooperative relations for knitting heel fabrics and for supporting the terminal wale loops of the instep fabric inactive on the instep needles, for the knitting of full courses in which the needles operate against the press edge of the machine, and for narrowing, will be briefly described in connection with illustrative figures of the drawings.

The operation of these parts for the knitting of heel fabric is particularly described in the series of diagrammatic Figures 21 to 28 inclusive. It is assumed that the narrowing points 239 have been rocked rearwardly to the heel knitting beard pressing position, and that the needle in-and-out motion cam roller 224 has been shifted to the right for engagement with its heel knitting cam so that the needles at the press will not be moved rearwardly a sufficient distance to cause their beards to be pressed against the press edge 174, but so that the active needles will be brought into pressing engagement with their cooperating beard pressing narrowing points 239. As previously pointed out, the knockover bits are supported and operated in such a manner as to require no change in the position or operation of these elements, whether for the knitting of full courses in which the needles move rearwardly against the press edge 174 or in the knitting of heel fabrics in which the needles are moved rearwardly a somewhat lesser distance to press the beard pressing narrowing points 239.

Fig. 21 illustrates the position of the parts at the completion of the coulier in which yarn has been fed to the needles 172 in their high position, the yarn measuring sinkers 176 have come in to measure the yarn against the needle shanks, and the dividers 178 have come in to re-measure and kink the yarn against all of the needles. The knockover bits 180 are in their fully retracted rearward position in which the cam followers 400 (Fig. 20) are engaged with the high portion of the cam face of the member 396. The beard pressing narrowing points 239 have now started their downward movement into position to cover the beards of the active needles.

Fig. 22 illustrates the position of the parts in which the needles have started downwardly and the narrowing points moving downwardly at a faster rate are approaching the beard covering position, and the needles have started to move rearwardly to press. In connection with Fig. 22, it will be noted that the narrowing points 239 must be moved downwardly far enough so that their tips are below the line of the newly kinked yarn designated at 462 before the tip of the point becomes embedded in the eye of the needle. The narrowing point will, however, be brought into a full engagement with the needle before the tip of the narrowing point has moved downwardly to the level of the previously formed fabric loops designated at 464 supported on the needle shanks below the sinker level.

Fig. 23 shows the needles fully pressed against the narrowing points with the needles 172 and narrowing points 239 still descending.

Fig. 24 shows the needle 172 still fully pressed against the narrowing point 239 with the tip of the needle beard now safely below the line of the loops of previously knit fabric 464. The loop of the newly kinked yarn 462 is drawn up into the head of the needle, and is stretched down-

wardly over the sinker nib as the sinker is about to recede.

Fig. 25 shows the parts in position as the needles have now moved forwardly in relation to the sinker retracting movement to draw the new loops downwardly off the sinker noses onto the nibs of the knockover bits 180. At the same time the loops 462 are drawn through the previously formed fabric loops 464 which have been cast off over the beards of the needles to form the new course of fabric. During this operation, the narrowing points 239 start to move upwardly to their raised inoperative position.

As shown in Fig. 26, the needles are now moved rapidly to the rear at the knockover level to cause the loops and the previously formed fabric to be placed to the back sides of the needles while at the same time the nibbed knockover bits are permitted to move forward under the influence of their springs 374 so that the nibs 360 are engaged with the bar of yarn in the sinker wale to certainly form the loops and to position the loops to the back sides of the needles. This movement of the knockover bits is permitted as previously described, as the result of the axial shifting movement of the cam rod 390 to the right, carrying with it the cam members 396 so that the followers 400 are permitted to ride against the lower portions of their cams.

Fig. 27 illustrates the parts in position as the needles now fully moved to their rearward position adjacent their press edges start to rise. The knockover bits 180 remain in their advanced position with the nibs 360 still engaged in the fabric to hold the fabric down and toward the backs of the needles as the needles rise.

Fig. 28 illustrates the position of the parts as the needles continue to rise toward the coulier position. At this time the knockover bits start to withdraw as the cam bar 390 is returned to the left to cause the follower 400 to move onto the high portion of the cammed end of the member 396.

The operation of the several cooperating knitting instrumentalities including the needles 172, sinkers 176, dividers 173 and knockover bits 180 for supporting the terminal wale loops of the instep fabric inactive on the instep portion of the needle series, is identical with that shown in Figs. 21 to 28 inclusive, with respect to heel knitting except that no yarn is fed to the instep needles and there are no narrowing points 239 acting in cooperation therewith to press the needle beards. As previously pointed out, the needle in-and-out or press motion is modified to cause the needles to cooperate with the beard closing narrowing points 239 for the knitting of the heel courses and also to prevent the engagement of the instep needle beards with the press edge 174 so that the terminal wale instep loops will be retained on the shanks of the needles. The arrangement and mode of operation of the knockover bits 180 above described, is of particular value to insure the knitting of properly formed loops under the different conditions of operation provided in the heel knitting, normal knitting, and for the support of the idle instep loops. The resilient mounting of the knockover bits both in a vertical and horizontal direction permits these elements to automatically adjust themselves to the differences in the press motions of the needles above noted in connection with heel knitting and full course knitting. The resilient setting of the knockover bits is of advantage also to maintain the terminal wale loops of the idled instep fabric on the shanks of the needles and with the instep fabric placed well to the back side of the idled instep needles to avoid any possibility of interference with the open beards during the movement of the needles. As will be evident from an inspection of Figs. 21 to 28 inclusive, the nibbed portions 360 of the knockover bits 180 are inoperative to engage with the fabric loops during a major portion of the knitting cycle, but are brought into operation for a short space of time only as the needles are moved rearwardly and then up from the knockover level to reposition and to hold down the fabric at this time, the knockover bits being then retracted so that the nib portions 360 thereof are again rendered inoperative. In this manner, a minimum of strain is placed on the terminal wale loops of the instep fabric held on the inactive needles, and any tendency of these loops to become enlarged with the consequent formation of a mark across the instep is avoided.

In accordance with the invention, the nibbed knockover bits 180 are particularly arranged and adapted to take the place of the usual fabric take-up particularly during the knitting of the heel fabrics, thus permitting the regular fabric take-up to be rendered inoperative during the knitting of the heel fabrics. The knockover bits operate as above described, and act resiliently to engage with and position the newly formed loops safely to the backs of the needles during the knockover and immediately thereafter as the needles start to rise to the coulier position. This take-up function of the knockover bits is of particular importance in connection with the knitting of the heel fabrics, since it renders unnecessary any changes in the weight of the fabric tension in accordance with the number of active knitting needles, and obviates any tendency to the cutting of yarn, tucking of stitches at the selvage and similar difficulties resulting from an improperly adjusted take-up mechanism. It has been found further that both for heel knitting and for full course knitting the knockover bit operation above described will in general eliminate the major effects of sleazy knitting, will produce a better appearing fabric with more perfectly formed loose courses and with the entire elimination of diamond or pineapple stitches. In this connection also, it is contemplated that during normal knitting a relatively light take-up tension may be employed which is substantially less than that normally employed, and has for its particular function the drawing of the fabric across the machine table to the wind-up roll.

For knitting on a 45 gauge full-fashioned machine, a satisfactory adjustment of the knockover bit tension particularly the forward and back tension to cause these elements to function properly and under all different conditions may be obtained as follows: Take-up tension springs are chosen which exert a tension in the neighborhood of twenty ounces. The knockover bit bar 362 is then adjusted on its support to and from the machine table in accordance with the following procedure. A course which is the tightest and with the finest yarn that the machine is expected to knit is couliered after the knockover bit bar has been provisionally mounted on its support. This course is couliered over the same number of needles as are used in the instep at the heel corners. This couliered fine course is then drawn down and the vertical position of the knockover bits is corrected so that the kinked yarn is drawn quite tightly over the knockover

surfaces but without any chance of cutting. During the subsequent rise of the needles, a similar adjustment is made in the horizontal position of the bar to avoid over-tautness of the yarn between the knockover bits and the needle shanks. A similar course is now knitted, and when the needles are in their most backward beard pressing position, the knockover bit bar is again adjusted in a forward or back direction so that the nibs of the knockover bits are in contact with the previously formed fine course, but not to the point where the nibs are forced hard against this course. The bar is then backed off four to six thousandths of an inch and secured in position. Care must be taken to see that the knockover bits are not set too far forward because the very slight difference of thickness of the single yarn in the non-knitting instep portion of the fabric during heel knitting and of the two active yarns of the heel portion is barely enough to prevent the knockover bits associated with the instep needles from acting upon and exerting undue pressure on the loops held on these needles.

For the performance of narrowing operations of a conventional sort, a somewhat modified operation of the knockover bits has been found desirable. The operation of the several cooperating instrumentalities including the knockover bits for the performance of a narrowing operation will be particularly described in connection with diagrammatic Figures 52 to 60 inclusive. It will be understood that the operation of the narrowing points **239** and needles **172** is in accordance with the usual practice, the only substantial change being in the employment and operation of the nibbed knockover bits **180** to engage with and hold down the transferred fabric loops. As shown in successive figures, the narrowing points move downwardly to cover the needle beards above the level of the fabric **464** as indicated in Fig. 53. The needles and narrowing points then move downwardly as shown in Fig. 54 to permit the narrowing points to disengage the loops over the tops of the needles as shown in Fig. 55, the needles and narrowing points then being raised as shown in Fig. 56 to permit the loops to be transferred lengthwise of the needle series, whereupon the narrowing points and needles are again moved downwardly, and the narrowing points are again caused to cover the needle beards with the needles in their fully lowered knockover position (see Fig. 51), whereupon the needles and narrowing points are again finally raised as shown in Figs. 59 and 60 to deposit the loops again upon the rising needles. At the start of the narrowing operation, the knockover bits **180** are permitted to move forwardly to their extreme forward position as the shogging of the cam shaft of the machine to the narrowing position acts to cause the low portion of the cam **396** to be brought opposite the follower **400** (see Figs. 10 and 20). During the first dip of the narrowing points and needles, the fabric loops will not be engaged within the nib **360** of the knockover bit. During the second dipping movement of the narrowing points in which the loops are returned to the needles, however, the rearward movement of the needles at the knockover level for causing the needle beards to be buried within the slots of the narrowing points, acts to engage the fabric loops in the nibs **360** of the resiliently supported knockover bits so that these loops tend to be stretched and re-formed away from the narrowing points to insure that the beards of the rising needles will be brought within the loop. As the narrowing points continue upward movement following the second dip to disengage these from the needles with the loops held thereon, the return shogging movement of the narrowing machine will cause the cam bar **390** to be again moved to the left, carrying with it the cams **396** so that the followers **400** are again brought into engagement with the high portions of their cams to move the knockover bits **180** rearwardly to the fully retracted position as shown in Fig. 60.

In accordance with the invention, a narrowing machine racking mechanism is provided which is capable of imparting indexing movements to the narrowing point fingers for the performance of the usual narrowing operations, and is further adapted for imparting to the narrowing point fingers the indexing and shifting movements necessary to cause the narrowing points to cooperate with the needles in a beard pressing capacity for the knitting of the shaped heels as above set forth. The narrowing point racking mechanism comprises a left and right threaded racking screw **470** on which is supported two oppositely threaded nuts **472**, **474**. The nut **472** is operatively connected with a sleeve bracket **476** slidably mounted on the front narrowing machine shaft **206**, and is provided with a downwardly extending lug **478** which engages against an adjustable stop screw **480** on a lug **482** fast to the rear side of narrowing point rod **232**. A tension spring **484** connected between the lug **478** and lug **482** on the narrowing point rod **232** acts to maintain the stop screw **480** normally in engagement with the lug **478**. The nut **474** is similarly connected with a sleeve bracket **486** which is slidably supported on the front narrowing machine shaft **206** and is provided with a downwardly extending lug **488** which engages with an adjustable stop screw **490** supported in a lug **492** secured to the rear side of narrowing point rod **234**. A tension spring **494** acts to maintain the set screw **490** normally in engagement with the abutment **488**.

The mechanism employed for stepping the narrowing fingers inwardly for the usual narrowing operations as best shown in Figs. 1 and 4, comprises a ratchet **498** fast on the narrowing machine racking screw shaft **470**, a pawl **500**, a supporting arm **502** for the pawl loose on shaft **470**, a connecting link **504**, a bell-crank lever **506** loosely supported to turn on the rear narrowing machine shaft **202**, a connecting link **508**, and a cam lever **510** supported intermediate its length to turn on a stud **512** supported on the back rail **186** of the machine. The cam lever **510** carries a follower roll **514** which, as best shown in Fig. 4, is normally located to the right of and out of engagement with the usual narrowing cam **516**, being arranged to be brought into engagement therewith by the shogging of the cam shaft **192** to the right for the performance of the usual narrowing operation.

A shield **518** is provided adjacent the ratchet **498** for disengaging the pawl **500** from the ratchet. The operation of the shield **518** is controlled from the pattern mechanism of the machine through connections which comprise a link **520** connected at one end to the pawl and at its other end to a lever arm **522** secured to a pivot shaft **524** supported in a bearing formed in a bracket **526** fast on the rear narrowing machine shaft **202**. There is also secured to the pivot shaft **524**, a second arm **528** which is connected by a downwardly extending link **530** with an arm **532** secured to a

forwardly extending rock shaft 534. At its forward end the rock shaft 534 is provided with a short lever arm 536 which is arranged to be engaged by a collar 538 on a pattern shift rod 540.

The mechanism provided for racking the narrowing point fingers outwardly one index at a time, and particularly during the operation of these fingers in their beard pressing capacity for the knitting of the heel-shaped fabric, comprises a ratchet 542 (see Fig. 18) and a cooperating pawl 544. As shown in Fig. 18, the pawl 544 is carried on a supporting arm 546 loose on the narrowing machine racking spindle shaft 470, and is actuated through connections comprising a link 548, a bell-crank 550 loosely supported to turn on the rear narrowing machine shaft 202, link 552 and a cam actuated lever 554 supported intermediate its length on a pivot 556 on the lower back rail 186 of the machine. A cam follower roller 558 is supported for axial movement on a pin 560 on the cam lever 554, and is arranged to be shifted axially to the right into engagement with either of two operating cams 562, 564, as best shown in Fig. 10. The cam roller 558 is arranged to be shifted by means of pattern control means comprising a shifting fork 566 which is secured to a pattern shift rod 568 and is arranged at its upper end to engage the grooved hub of the follower roller 558. In order that the pawl 554 may be readily thrown into and out of operation as desired, a shield 570 is loosely mounted to turn on the narrowing machine racking spindle shaft 470, and is provided with a cam surface which is engaged by an offset portion of the pawl 544 for the relatively advanced position of the shield. The position of the shield is controlled from the pattern chain of the machine through connections which comprise a link 572, a lever 574, link 576, a bell-crank 578 pivoted on a bracket 580 on the lower rib rail 186 and a forwardly extending link 582. The forward end of the link is arranged to be acted upon by a cam 584 on a pattern shift rod 586.

A feature of the invention consists in the provision of a novel mechanism for effecting a rapid movement of the narrowing point fingers inwardly a relatively large distance between two successive courses. This operation is performed, for example, in the knitting of the heel fabrics following the knitting of the last short course of one heel gore and prior to the knitting of the first long course of the next heel gore. For effecting the rapid inward movement of the narrowing point fingers, an auxiliary motor drive is provided comprising a low voltage stallable type electric motor 588 (see Figs. 4 and 5) which is mounted on a bracket 590 sleeved on the front narrowing machine shaft 206 and on the narrowing machine racking spindle shaft 470. A gear 591 on the armature shaft of the motor 588 meshes with a gear 592 on a parallel shaft 594 which at its lower end carries a bevel gear 596 which meshes with a cooperating bevel gear 598 on the narrowing machine racking spindle shaft 470. At its upper end the parallel shaft 594 is provided with a manually operable lever arm 600 for the convenience of the operator in the event that it is desired to rack the narrowing machine spindle by hand.

The control mechanism for rendering the motor 588 operative to effect the rapid inward movement of the narrowing point fingers 236, 238 as best shown in Figs. 5 and 7, comprises an electrical circuit having wires 610, 612 and two microswitches 614, 616 arranged in series in the circuit. The arrangement of these switches is such that when both switches are closed at the same time by the release of the switch plungers, the circuit will be closed to drive the narrowing spindle quick return motor 588. As best shown in Fig. 7, the switch 616 is arranged to be acted upon by a cam actuated spring arm 618 having a follower roll for engagement with a cammed abutment 620 on one of the pattern shift rods 622 of the machine. The micro-switch 614 above referred to, forms part of an automatic mechanism for initiating and for controlling the extent of the rapid inward movement of the narrowing point fingers. This mechanism includes also an auxiliary cam shaft, a series of adjustable stops supported thereon for engagement with cooperating abutments on the narrowing finger supporting rods, a motor control cam carried by the auxiliary cam shaft, and a pattern controlled pawl and ratchet actuating mechanism for the auxiliary pattern cam shaft. As best shown in Figs. 5 and 7, the auxiliary pattern cam shaft 624 referred to, is mounted on the narrowing machine directly in front of the forward narrowing machine shaft 206 in brackets 626, 628, and has mounted thereon a combination cam and stop element in the form of a cam plate 630 which has secured at opposite sides thereof four adjustable screw stops. The stops at the left side of the plate as shown in Fig. 7, are generally designated at 632, and are arranged for engagement selectively with an abutment on a cooperating stop block 634 secured to the left hand narrowing point bar 234. The stops at the right side of the cam 630 designated generally at 636 are similarly arranged for alternate engagement with an abutment on a stop block 638 secured to the right hand narrowing point finger bar 232. The cam 630 engages a spring follower arm 640 which is associated with the switch 614, and acts when the follower 640 rides on the high portion of the cam 630 to open the switch.

The pattern controlled pawl and ratchet mechanism for imparting stepped rotational movements to the auxiliary cam shaft 624 comprises a ratchet 642 (see Figs. 5, 7, 8 and 9), a cooperating pawl 644 pivotally supported on a lever 646 loose on the auxiliary cam shaft 624, a connecting link 648, a bell-crank lever 650 supported to turn on the narrowing machine racking spindle shaft 470, a link 652 connecting the bell-crank 650 with a lever 654 loose on the rear narrowing machine shaft 202, a downwardly extending connecting link 656 and a cam actuated lever 658 pivotally supported on a bracket 660 on the lower rear rail 186 of the machine. A stud 662 on the forward end of the cam lever 658 provides a mounting for an axially shiftable cam roller 664 which is supported normally to the left of and out of engagement with its cooperating cam 666. A shifting fork 668 at one end engaging with the sleeve hub of the cam roller 664 and at its other end secured to the pattern shift rod 622 provides a convenient means for controlling the position of the roller. The cam roller 664 is held clear of the idle or non-working portion of its co-acting cam 666 by engagement of an adjustable screw stop 670 with an abutting portion of the lever. A tension spring 672 secured to a hook-shaped projection of the cam lever 658 tends to move the lever and follower roller 664 in a clockwise direction as shown in Fig. 5, to maintain the roller in engagement with its cam.

The control mechanism for causing the narrowing point fingers to be moved rapidly inwardly is shown in Figs. 5 and 7 in its normally inopera-

tive position in which the angular position of the auxiliary cam shaft 624 is such that the adjustable screw stops 632, 636 are out of alignment with the abutments on stop block 634 and 638 respectively. The spring follower arm 640 associated with the switch 614 is on the high portion of its cam with the switch plunger depressed so that the switch 614 is in its open position. The pattern shift rod 622 is in its idle position to the left in which the cam roller 664 associated with the pawl and ratchet rotating means for the auxiliary cam shaft 624 is out of alignment with its cam 666 on the main cam shaft 192, and the spring follower arm 618 associated with the switch 616 is riding against the low portion of its cam 620 so that the switch 616 is closed. When in the knitting of the heel gores or segments such gore has been completed, the control mechanism above described is rendered operative to rapidly move the narrowing points inwardly over the relatively great distance to a position in which to knit the first long course of the following heel segment or gore.

The operation of the control mechanism to shift the narrowing point fingers rapidly inwardly is briefly as follows: Two courses or chain racks ahead of the knitting course, in which the beard covering narrowing points are to be employed for the knitting of the first long heel course of the new gore, a chain rack is employed to move the pattern shift rod 622 to the right, so that the cam roller 664 is moved into alignment with its cam 666 to render the pawl and ratchet indexing mechanism for the auxiliary cam shaft 624 operative. This movement of the pattern shift rod 622 also acts to move the follower arm 618 onto the high portion of its cam 620 to open the switch 616. Continued rotation of the cam shaft 192 causes the pawl and ratchet mechanism actuated by the cam 666 and roller 664 to index the auxiliary cam shaft 624, so that the follower arm 640 is moved off of the high portion of its cam 630 while the appropriate stops 632, 636 are moved into alignment with the abutment on the stop blocks 634, 638. The next following chain rack is employed to again shift the pattern shift rod 622 leftwardly to its normal position shown in Fig. 7, thereby closing the switch 616, and since switch 614 is closed, energizing the motor 588. The rotation of the narrowing machine racking spindle shaft 470 causes the narrowing point fingers to be moved relatively inwardly until the abutment blocks 634, 638 engage respectively against the appropriate stops 632, 636. The motor 588 then stalls. The next following chain rack is employed to again shift the pattern shift rod 622 to the right, opening the circuit through switch 616, and again aligning the cam roller 664 with its cam 666 to index the auxiliary cam shaft 624. The stepped rotational movement of the auxiliary cam shaft 624 causes the follower 640 to ride onto the high portion of its cam to open the switch 614. The next following rack of the pattern chain is employed to shift the patern shift rod 622 to its normal position to the left to disengage the cam roller 664 and to permit the closing of the switch 616.

The actuating and control mechanism for the narrowing point fingers 236, 238 is particularly constructed and arranged for operation in accordance with the method particularly set forth in Figs. 30 to 32 inclusive, in which it is proposed to move the left hand narrowing finger 238 inwardly a large number of needle indexes a full course in advance of the right hand narrowing finger 236. This operation takes place after the knitting of the last short course of the left hand heel gore and before the knitting of the first long course of the succeeding gore in which the traverse of the yarn carrier will be from left to right. In connection with Fig. 4 of the drawings, it will be noted that the nut 474, sleeve bracket 486 and lug 488 during their inward indexing movements to the right engage with the stop screw 490 to force the carrier bar 234 and left hand narrowing point finger 238 inwardly to the right, and that during leftward or outward racking movement of these parts, the narrowing point finger supporting bar 234 is drawn outwardly under the influence of its spring 494. Similarly, the narrowing machine nut 472, sleeve bracket 476 and lug 478 act on the stop screw 480 to move the right hand narrowing finger supporting bar 232 and finger 236 inwardly, while outward movement of the bar and associated finger is effected by the influence of spring 484. In accordance with the method above described in connection with Figs. 30 to 32, the left hand narrowing point finger supporting bar 234 and fingers 238 carried thereby are moved manually inwardly to the right, the machine being momentarily stopped for this purpose and are then held in this inward position for the knitting of one course by means of a latch mechanism shown in Fig. 4. This mechanism comprises a stop lever 673 pivoted on a stud 674 on one of the narrowing finger supporting brackets 230, and a cooperating stop abutment 675 fastened to the rear side of the left hand narrowing point finger supporting bar 234. The stop lever 673 is held normally in a raised inoperative position by means of a spring-pressed latch 676 which engages with a flattened pin 677 on the stop lever 673. A forwardly extending pin 678 on the side of the stop lever 673 provides a convenient handle for operation of the lever by the operator. When the knitting of a heel gore has been completed, the operator trips the latch 677 so that the stop lever 673 is permitted to drop onto the stop abutment 675. The narrowing point finger supporting bar 234 is then moved to the right against the tension of its spring 494 until the stop lever 673 drops behind the abutment 675. The relation of the stop lever 673 and stop 675 is such that the beard covering points of the left hand narrowing point fingers 238 are in correct alignment with their cooperating needles during the knitting of the first long course of a left hand heel gore. This position is held during the coulier from left to right and during the immediately following loop forming operation. During the loop forming and before the following coulier from right to left, the rapid inward shift of the narrowing point finger mechanism takes place through the energizing of the rapid shift motor 588 as above described. This operation now brings in the right hand narrowing point fingers, while the simultaneous inward movement of the left hand narrowing machine nut 474 and its associated parts will cause the abutment 488 to be again brought into engagement with the stop 490 on the left hand narrowing point supporting bar 234. The stop lever 673 is now manually raised to its inoperative latched position shown in Fig. 4, the machine being again temporarily stopped for this purpose, so that during the subsequent knitting of the heel gores, both left and right narrowing point fingers will be indexed outwardly in unison in a normal manner.

The multiple section cotton type knitting

machine disclosed in the drawings, is provided with the usual yarn carrier mechanism comprising a series of eight yarn carrier rods which extend along the length of the machine above the knitting sections and below the narrowing machine previously described, being supported at intervals along their length in brackets such as that shown at 689 in Figs. 1 and 5, secured to the sinker rail 184 of the machine. Each of these carrier rods has secured thereto at each knitting section, a yarn carrier which extends downwardly to a point just to the rear of the beard side of the needle series and below the top line of the sinkers as shown in Figs. 5, 85, 86 of the drawings. The yarn carriers 102, 104, 106 and 108 previously referred to in connection with the description of the heel knitting are particularly shown in Fig. 5, and are mounted on carrier rods identified respectively at 782, 784, 786 and 788.

The carrier rods and carriers associated therewith are traversed across the width of the needle series to feed yarn by a coulier mechanism acting through driving frictions in accordance with the usual practice in these machines. The sinkers are advanced in a knitting wave to kink the newly fed yarn about the shanks of the needles by a slur-cock driven also from the coulier mechanism. The extent of movement of the friction driven yarn carriers in each direction is determined by means of carrier stops which are interposed in the paths of cooperating stop abutments on the carrier rods. These mechanisms are well known in the art and are not here specifically illustrated except so far as necessary to illustrate the connection of the present invention therewith.

In accordance with the present invention, a novel inner carrier stop mechanism including automatic control means therefor and an outer stop mechanism including a novel and improved control mechanism therefor are provided for controlling the operation of the heel carriers during the knitting of the heel fabrics. The mechanism for controlling the operation of the inner and outer carrier stops is constructed and arranged to operate in cooperation with the control mechanism above described for controlling the narrowing machine operation to cause the narrowing points to operate in the capacity of beard pressing elements for the knitting of the heel fabrics.

The inner carrier stop mechanism of the machine as shown in Figs. 5, 7, 8 and 9, comprises a left inner carrier stop housing 790 and a right inner carrier stop housing 792. The left hand housing provides support for two vertically adjustable stepped carrier stops 794 and 796 which are arranged for engagement respectively with adjustable screw stops 798, 800 carried respectively by the left hand inner stop carrier bars 782, 784. The right hand housing 792 similarly provides support for two vertically adjustable stepped stops 802, 804, which are arranged for engagement respectively with adjustable screw stops 806, 808 on the right hand inner carrier rods 786, 788. The inner carrier stop housings 790, 792 are formed with left and right threaded nut portions which are threaded to an oppositely threaded inner stop screw spindle 810, and are further provided with rearward extensions which are sleeved on a supporting tie shaft 812 extending lengthwise of the machine and rigidly supported at intervals in upstanding brackets 814 which form extensions of the machine frames 162 previously described. The inner stop screw spindle 810 is supported with relation to the tie shaft 812 in an extension of a bracket 814 and in bearings formed in brackets 816 and 818 carried on the tie shaft 812.

Stepped rotational movements are imparted to the inner carrier stop spindle 810 for racking carrier stop housings 790, 792 either inwardly or outwardly as may be desired, by means of a pattern controlled pawl and ratchet mechanism which comprises a ratchet 820 secured toward the right hand end of the shaft as shown in Figs. 5 and 7, for the inward racking of the inner carrier stops and a ratchet 822 adjacent the ratchet 820 for the outward racking of the inner carrier stops. The ratchets are arranged to be acted upon respectively by an inward racking pawl 824 and an outward racking pawl 826, both pawls being pivoted on a stud 828 on a pawl lever 830 loosely mounted to turn on the rear narrowing machine shaft 202. The depending arm of the pawl lever 830 is connected by a link 832 with cam lever 834 carried on the stationary bracket 660 and provided at its outer extremity with a stud 836 supporting for axial movement thereon a cam roller 838. A shifting fork 840 engaging at one end the hub of the cam roller 838 and at its other end secured to a pattern shift rod 842 acts to shift the roller 838 into engagement with either of two operating cams 844, 846. The cam roller 838 is supported in a position above the level of the idle or non-working portions of its coacting cams by the engagement of an adjusting screw 848 on a depending arm of the cam lever 834 with the lower back rail 186 of the machine. The pawls 824, 826 are urged toward one another by a tension spring 850 being held, however, in spaced relation through the engagement of an adjustable screw stop on one of the pawls with a lug on the other pawl. The position of the pawls to render one or the other of them active as may be desired, is controlled through pattern control connections comprising a link 852 connected at its upper end to the pawl 824 and at its lower end through a yieldable connection with an arm 854 on a forwardly extending rock shaft 856 in the base of the machine. Rocking movement is imparted to the rock shaft 856 by means of a cam and follower lever connection with a pattern shift rod which is not here shown, but which is similar to the mechanism employed for racking the auxilitary cam shaft 892 including rock shaft or torque rod 908, lever arm 910, cam block or abutment 912 and shift rod 914 illustrated in Fig. 7 and hereinafter described.

The racking of the inner carrier stops in accordance with the normal operation of the machine takes place about midway through the coulier or slur-cock motion. In the illustrated machine, this racking movement of the inner carrier stops in accordance with the normal operation of the machine is effected by means of a cam 845 shown in Fig. 5, acting against the cam follower roller 838. For the knitting of the successively shorter courses of the heel gores in accordance with the method particularly illustrated in Figs. 34 to 36 inclusive of the drawings, a different timing of the outward movement of the inner carrier stops is required. In order to condition the inner carrier stop racking mechanism for these outward stepping movements of the carrier stops, the shift rod 842 and cam roller 838 are arranged to be moved to an extreme position to the right through the agency of a high bump on the pattern chain so that the roller is brought into engagement with a cam 844 shown

in Fig. 5. The cam 844 is constructed and arranged to cause the inner carrier stops to be shifted outwardly at that point in the knitting cycle when the loops have been drawn from the noses of the sinkers and the needles are in their extreme forward position prior to the knocking over of the loops.

For effecting the rapid inward movement of the inner carrier stops following the knitting of the last short course of one heel gore and the knitting of the next first long course in the succeeding gore in accordance with the invention, a low voltage stallable electric motor 860 is provided, mounted in a fixed bracket 862 and having secured thereto a spur gear 864 which meshes with a spur gear 866 on a vertically disposed drive shaft 868 also rotatably supported in bearings on the bracket 862. At its lower end the shaft 868 carries a bevel gear 870 which meshes with a bevel gear 872 secured to the inner carrier stop spindle 810.

Control mechanism for rendering the motor 860 operative to effect rapid inward movement of the carrier stops, as best shown in Figs. 5 to 9 inclusive, comprises an electrical circuit having wires 874, 876 and two micro-switches 878, 880 arranged in series in the circuit. The switch 880 is arranged to be acted upon by a cam actuated spring arm 882 having a follower roll for engagement with a cammed abutment 884 on a pattern shift rod 886 of the machine. The micro-switch 878 (see Fig. 6) is arranged to be acted upon by a spring arm 888 having a follower roller arranged for engagement with a cam member 890 secured on an auxiliary cam shaft 892 supported rearwardly of and above the inner carrier stop spindle 810 in bearings formed in the brackets 814, 816. For limiting the rapid inward movement of the inner carrier stop housings 790, 792 by reason of the operation of the electric motor 860, four adjustable stops 894 are provided mounted on one face of the cam 890 for selective engagement with a cooperating stop arm 896 formed integrally with the right hand inner stop housing 792. Rotational movement is imparted to the auxiliary rock shaft 892 through connections controlled from the pattern chain of the machine including a ratchet 898 on the auxiliary cam shaft 892, a cooperating pawl 900 carried on a supporting arm 902 loose on the cam shaft 892, and a downwardly extending link 904 connecting the pawl lever with an arm 906 on a forwardly extending torque rod 908 in the base of the machine. At its forward end (Figs. 7 and 87) the torque rod 908 is provided with a lever arm 910 having an offset pin for engagement with a cam abutment 912 on a pattern shift rod 914.

The operation of the control mechanism for initiating the rapid inward movement of the inner carrier stops, while similar in many respects to that previously described for effecting the simultaneous inward movement of the narrowing point fingers will be briefly described in connection with Figs. 5, 6 and 7 as follows: The parts as shown in these figures, are in a position of rest in which the pattern shift rod 914 is in its left hand inoperative position and the auxiliary cam shaft 892 is positioned with the stops 894 out of alignment with the stop abutment 896 and with the spring-pressed switch arm 888 in a fully depressed position against a high portion of its cam 890 to open the switch 878. It is assumed further that the inner carrier stop housings 790, 792 have been moved outwardly and stand in the positions which will be taken at the completion of the knitting of the last short course of a heel gore. A rack of the pattern chain causes the pattern shift rod 914 to be shifted to the right to rock the torque rod 908 and thereby to impart an increment of rotational movement to the auxiliary cam shaft 892, thereby moving one of the stop screws 894 into alignment with the stop abutment 896 and causing the switch arm 888 to ride off the high portion of its cam 890 to close the switch 878. At the same time a pattern shift rod 886 is moved to the right, causing the switch arm 882 associated with switch 880 to move onto the high portion of its cam 884 and thereby to close the switch 880. The closing of the two switches energizes motor 860, causing the stop housings to be moved rapidly inwardly until arrested by the engagement of the stop abutment 896 with the stop 894. The motor 860 is now stalled. The following chain rack is employed to permit the shift rod 886 to be again moved to the left to the normal position shown in Fig. 7, thereby opening the circuit through switch 880. During subsequent machine operation, the pattern shift rod 914 is again shifted to the right to again rack the auxiliary cam shaft 892 so that the parts are returned to the inoperative position of Fig. 6, in which the abutment 896 is out of alignment with the stops 894 and the switch arm 888 again rides on a high portion of its cam 890 to maintain the switch 878 in open position. With this construction and arrangement of the control mechanism, it will be evident that the pattern control rods 914 and 886 must be shifted at the same time to effect the simultaneous closing of the two switches 880 and 878 in order to energize the quick return motor 860.

The stepped racking movement imparted to the auxiliary cam shaft 892 is employed also to automatically control the vertical position of the stepped inner carrier stops 794, 796, 802 and 804 when so desired as, for example, in the knitting of the stepped high heel reinforced areas of the stocking blank or in the event that it is desired to use the steps for starting successive heel gores outwardly from one another in place of the rapid traverse motor above described. Connections provided for this purpose (see Figs. 5, 7, 8, 9, 16 and 17) comprise a rock shaft 918 supported in bearings provided in the brackets 814, 816 and 818, and a frame supported therefrom comprising lever arms and a connecting rod 920 having slidable link connections with each of the vertically shiftable carrier stops 794, 796, 802 and 804. A cam follower ever arm 922 secured to the rock shaft 918 is arranged for engagement with a follower cam 924 on the auxiliary cam shaft 892. In order to bring one or another stepped surface of the inner carrier stops into operative relation to their cooperating screw stops on the associated carrier rods, a racking movement of the pattern chain is employed to rock the torque rod 908, and through the ratchet and pawl connections above described, to impart a rotational movement to the auxiliary cam shaft 892. It will be understood that this movement of the auxiliary cam shaft is ineffective to initiate a rapid inward movement of the inner carrier stop housings for the reason that no accompanying shift of the pattern shift rod 886 takes place and the switch 880 therefor remains in its open position to prevent energizing of the rapid return motor 860.

The outer carrier stop mechanism for controlling the reversing position of the carriers associated with carrier rods 782, 784, 786 and 788

is particularly illustrated in Fig. 29 of the drawings. This mechanism is similar to that illustrated for racking the inner carrier stops illustrated in Figs. 5 and 7, and consists of an oppositely threaded outer carrier stop spindle 930 to which are threaded a left outer carrier stop housing 932 and a right outer carrier stop housing 934. The left outer carrier stop housing 932 provides support for stops 936 and 938 which cooperate with screw abutments 940 and 942 carried respectively on carrier rods 782 and 784. Two stops 944 and 946 carried in the right hand outer carrier stop housing 934 are arranged for engagement respectively with screw stops 948 and 950 respectively on the carrier rods 786 and 788. The outer carrier stops are capable of both inward and outward racking through the mechanism shown in plan in Fig. 29, which is identical in arrangement and construction with the mechanism previously described and shown in side elevation in Fig. 5, for imparting alternate inward and outward racking movements to the inner carrier stops. This mechanism comprises an inward racking ratchet 952, an outward racking ratchet 954 and cooperating pawls 956 and 958 supported on a pawl lever 960 pivoted on the rear narrowing shaft 202, this lever being connected at its lower end by means of a forwardly extending link 962 with a cam lever 964 on which is supported a follower roller 966 for selective engagement with cams 968 and 969 on the main cam shaft 192 of the machine. The roller 966 is arranged to be moved axially into alignment with its cams 968, 969 by means of a shifting fork 970 carried on a pattern shift rod 972 of the machine. The cam 968 acts through roller 966 to rack the outer carrier stops inwardly in accordance with a normal sequence of operations of the knitting instrumentalities for the production of fabric narrowings. The usual shogging of the cam shaft 192 to the right to the narrowing position is effective to shift the narrowing cam 969 into engagement with the roller 966. For the formation of the widened selvage in accordance with applicant's method, as shown in Figs. 69 to 85 inclusive, the outer carrier stops are shifted outwardly two needle indexes at a later than normal point in the knitting cycle as the knockover bits come in, that is, toward the end of the coulier stroke. For the performance of this fabric widening operation, the shift rod 972 and follower roller 966 are shifted by a bump on the pattern chain to the right from the position shown in Fig. 29, in which the roller is acted upon by a racking cam 968.

The separated pawls 956, 958 are arranged to be shifted to cause one or the other pawl to be moved into operative relation to its ratchet through connections from the pattern chain of the machine comprising a vertical link 974 connected to the pawl 958 and at its lower end to a horizontal arm 976 of a bell-crank lever, the other arm of which is connected to a forwardly extending shift rod 978 at the base of the machine. At its forward end the shift rod 978 is arranged to be acted upon by a cam block 980 on a pattern shift rod 982. Movement of the shift rod 982 to the right from the position shown in Fig. 29, will act to raise the separated pawls so that the upper pawl 956 is raised to inoperative position, and the lower pawl 958 is brought into active engagement with its ratchet 952.

A rapid return motor 984 of the stallable type supported on a bracket 986 and connected through bevel gears 988, 990 with the outer carrier stop spindle 930 provides power means for effecting the rapid movement of the outer carrier stop housings from one to another position. The controls for motor 984 are not here described or illustrated in detail for the reason that rapid movement of the outer stops is not required during knitting of the heel portion of the hosiery blank here described. The motor 984 may be readily controlled from the pattern mechanism of the machine in the manner described and illustrated for controlling the rapid return motors for the narrowing point units and inner carrier stops. Manual operation of the spindle is effected by means of a handle 992 carried on a forwardly extending shaft 994 which is connected at its rear end with bevel gears 996, 998 with the spindle 930.

A novel arrangement of the pattern chain and pattern levers actuated thereby is illustrated in Figs. 11 to 15 of the drawings. The pattern chain designated at 315 in accordance with ordinary practice is an endless chain and is adapted to be driven by means of a pawl and sprocket mechanism located at the left hand end of the machine. In accordance with the invention, the pattern chain 315 is an endless chain constructed and arranged with pattern buttons or bumps on the inner as well as the outer face of the chain, so that a second series of paths is provided on the inner face of the chain, on which buttons or bumps may be located for engagement with a second set of pattern levers. Referring to the figures, the pattern chain 315 rides upon a drum 1000 supported upon a pivot shaft 1002 mounted on a frame or bracket 1004. The drum is provided with outwardly extending notched flanges in the nature of sprockets upon which the chain rides. The chain is arranged also to ride upon a second drum 1006 carried on a pivot shaft 1008, the drum 1006 being similarly provided with outwardly extending notched flanges or sprockets which engage against the outside surface of the chain at its under side. The notched flanges on the drums are spaced from one another, and are of sufficient width to permit buttons on that side of the chain which faces the particular drum around which the chain is passing, to move between the flanges out of contact with the face of the drum.

The drums 1006 together with their respective shafts 1002 and 1008 are connected to be driven as a unit by means of a pinion 1010 on shaft 1002 which meshes with a pinion 1012 on shaft 1008. A stepped motion is imparted to the drums and pattern chain 315 by connections from the cam shaft which may be of ordinary description (see Figs. 10 and 11), and include a ratchet 1016 on shaft 1002, a pawl 1018, a pawl lever 1020, connecting link 1022 and a bell-crank cam actuated lever 1024 with follower roll 1026 arranged to ride on cam 1030 on the main cam shaft 192.

The pattern chain 315 is provided on the external periphery thereof with buttons or bumps such as that shown at 1032 connecting successive links of the chain. These bumps are arranged for engagement with cooperating pattern chain cam levers 1034 carried on a pivot shaft 1036 on bracket 1004, and having the upper arms thereof connected with pattern rods by means of connecting links such as that shown at 1038 which connects specifically with pattern rod 358 (see Fig. 10). The pattern chain 315 is also formed with inwardly disposed buttons or bumps such as those indicated at 1039 in dotted lines in Fig. 14 and in full lines in Fig. 15. The button

1039 is arranged as it passes over drum 1006 to act upon a cooperating pattern chain cam lever 1040 which is one of a series carried on a pivot shaft 1042. The chain lever 1040 is secured to the pivot pin 1042 adjacent one end thereof. Adjacent the other end of the pivot pin 1042 there is an upwardly extending lever arm 1044 which is arranged to be connected in a normal manner with one of the pattern control rods of the machine. As best shown in Fig. 13, the pattern chain lever 1046 adjacent the lever 1040 is formed with a sleeve hub mounted on the pivot pin 1042. An upwardly extending lever arm 1050 is mounted on the sleeve hub at its other end adjacent the arm 1044 and is adapted to be connected in the usual manner with one of the pattern control rods of the machine. A third pattern chain cam lever 1048 mounted adjacent the lever 1046 is similarly formed with a sleeve hub which is freely rotatable on the sleeve hub of the lever 1046, and is similarly formed with an upwardly extending arm which is adjacent the arm 1050 and is arranged to be connected with another pattern control rod of the machine.

From the foregoing description, it will be noted that an arrangement of the pattern mechanism is provided which permits of a substantial increase in the number of pattern chain cam levers which may be controlled from a pattern chain of a given width, this increase being achieved by the addition of the second pattern chain drum 1006 and pattern chain cam levers which are disposed interiorly of the chain and are formed with elongated sleeve hub portions which pass beyond the outer edge of the chain and provide support for upwardly extending pattern chain connecting lever arms at one side of the pattern chain. With the illustrated construction, each of the drums is so constructed and arranged as to support the chain away from the drum a sufficient distance to provide clearance for the buttons disposed on that side of the chain toward the drum.

The operation of the flat full-fashioned "legger" type knitting machine herein illustrated, for the production of a combination foot and leg hosiery blank having applicant's improved heel knitted in accordance with the method of the present invention, will be briefly described with particular reference to the several novel features of construction and operation of the machine provided in accordance with the invention.

The leg portion of the hosiery blank is knitted in accordance with standard practice and with the several operationing and control mechanisms of the machine operating in a normal manner, except that in accordance with the preferred form of the invention herein disclosed, a novel and improved knockover bit motion is employed which, as previously pointed out, consists in the use of a nibbed knockover bit which is spring-biased upwardly and forwardly, and is supported in a relatively retracted position during the knitting cycle except for a brief interval during the rearward and upward movement of the needles from the knockover lever when the nibbed portions are permitted to move forwardly to engage with and position the newly formed loops to the back sides of the needles. During leg knitting, the narrowing point units 236, 238 associated with each of the several knitting sections, operate in the normal manner to effect the usual leg narrowing, only the innermost 18 points of each unit, however, being employed for this purpose, the remaining points to which no yarn is being

fed merely going through a dummy motion with the needles co-acting therewith. In the knitting of the ankle portion of the blank prior to the starting of the heels, a number of courses of the same length are knitted, in which no narrowing takes place, and in which the high splice portions of the blank are being formed. The last course of knitting before the starting of the heel gores comprises a traverse from right to left as shown in Fig. 61 of the drawings, a body carrier 100 and two high splicing carriers 102 and 104 being in operation at this time.

Several preliminary positioning operations are required to condition the machine for heel knitting. These operations include the transfer of the narrowing point units inwardly into the position indicated in Fig. 62 of the drawings for the knitting of the first heel gore, the changing of yarn carriers to disconnect the previously knitting body and high splicing carriers and to connect the four heel carriers for active operation, the positioning of the inner carrier stops for said heel carriers to cooperate with the narrowing point units for the feeding of yarn only to the needles rendered active by the cooperation of the narrowing points therewith, and the positioning of the outer carrier stops for the heel carriers to form the selvage edges of the heel fabric.

After these preliminary positioning operations have been effected, a number of shifts take place in the operating mechanism whereby the machine is conditioned for the knitting of heel fabrics as follows: The operating shifts referred to include the shifting of the narrowing machine vertical motion cam roller onto the heel knitting cam, the rocking of the narrowing point units on the narrowing machine frame rearwardly from the narrowing to the heel knitting position, the shifting of the needle press cam roller into engagement with the heel knitting cam, and the easing off of the usual take-up tension exerted on the fabric take-up rollers. When knitting then starts, the narrowing point unit racking spindle is given an indexing movement outwardly one needle for each successively knitted course, and the inner carrier stops cooperating therewith are given a two-needle indexing movement outwardly in alternate courses. During the knitting of the first and second gores of the fabric heel particularly illustrated in Figs. 45 and 46 of the drawings, the outer carrier stops are given a two-needle outward indexing movement for the knitting of each fourth successive course.

The inward positioning of the narrowing point units is initiated from the pattern chain of the machine by means of a pattern shift rod 622. A chain rack which is the first of a series of four such racks, shifts the shift rod 622 to the right to open switch 616 for the narrowing point unit rapid movement motor 588 and engages roller 664 with its cam 666 to impart an indexing movement to the auxiliary cam shaft 624. This movement of the auxiliary cam shaft closes switch 614 and causes the shortest pair of stops 632, 636 to be moved into the path of narrowing point unit abutments 634, 638 respectively. The following or second chain rack of the series operates to move the shift rod 622 again to the left, closing switch 616 to complete the circuit to the motor 588 which drives the narrowing point units rapidly inward to a position determined by the stops 632, 636 when the motor stalls. The next or third chain rack now moves the shift rod 622 again to the right to engage roller 664 with its cam 666 to impart a second indexing movement

to the auxiliary cam shaft 624, moving the stops to an intermediate neutral position and disengaging the switch 614 to de-energize the motor. The fourth chain rack returns the shift rod 622 again to the left, closing the switch 616 and completing the series.

In order to provide an accurate register of the narrowing point units with the needles, the stop screws 632, 636 are adjusted to allow the narrowing point units 236, 238 to be moved one index beyond the needles with which the individual points are to be aligned. The narrowing point units 236, 238 are then immediately racked outwardly one index to secure the proper alignment of the narrowing points and needles. To this end the second chain rack of the series which acts as above set forth to effect the rapid inward movement of the narrowing point units, is employed also to cause the shift rods 586 and 568 to be shifted to the right (see Fig. 10), movement of the shift rod 586 acting to set the shield 570 for one index racking by pawl 544, and the movement of shift rod 568 acting to move the racking follower roller 558 into engagement with the narrowing point spindle outward racking cam 564. The next racking movement of the chain returns the shift rods to their neutral position.

The inner carrier stops may be similarly positioned for the knitting of the first long course of heel fabric by the operation of the inner carrier stop rapid return motor 860 previously described. This movement is initiated by the pattern cam shaft through the operation of shift rod 914, which when shifted to the right acts to impart an indexing movement to the inner carrier stop auxiliary cam shaft 892, and through the associated operation of the switch control pattern shift rod 886. As shown in Figs. 5, 6 and 7, the rack of the pattern chain causes pattern shift rod 914 to be shifted to the right, rocking torque rod 908 to index the auxiliary cam shaft 892, thus bringing the shortest of the stop screws 894 into alignment with the stop abutment 896 and closing switch 878. The same pattern chain rack causes the switch control pattern shift rod 886 to move to the right, closing switch 880. The closing of the two switches energizes the motor 860, causing the inner carrier stop housing to be moved rapidly inwardly until arrested by the engagement of the stop abutment 896 with the stop 894, when motor 860 stalls. During subsequent chain racks, the inner carrier stop auxiliary cam shaft is again indexed to an intermediate inoperative position to open switch 878, and switch 880 is also opened.

The position of the outer carrier stops is readily controlled from the pattern chain of the machine through the operation of the usual racking controls including pattern operated shift rod 972 which controls the position of the outer carrier stop racking follower roller 966 (see Fig. 29), and pattern shift rod 982 which controls the position of the outer carrier stop inward and outward racking pawls 956 and 958.

At the completion of the last course of leg knitting in which the coulier is from right to left, the knitting yarn carriers including the body yarn carrier 100 and splicing yarn carriers 102 and 104 will occupy the positions shown in Fig. 61.

Now it is necessary to have two short course carriers operating in each heel area, and with the form of the invention illustrated in Figs. 61 to 64 inclusive, these carriers must start knitting simultaneously on the right and left heel areas to avoid casting off the fabric by the beard pressing narrowing point units which are moved in and rendered operative for the knitting of the first heel course simultaneously as above set forth. The body carrier is made inoperative and moved to a position outside the bank of needles, while two idle carriers 106 and 108 are made operative. Carrier 106 is manually traversed inward to the position shown in dot-and-dash lines in which the starting end will be looped into the instep fabric while the machine is stopped with the needles down and the sinkers retracted (needles and sinkers in same position as in Fig. 25). The machine now couliers from left to right, making the first heel course. Fig. 62 shows the first long course in the first gore in both the left and right hand heels.

During the knitting cycle of the preceding course, that is, during a coulier from right to left, a chain button will have moved a chain lever connected to the shift rod 293 (Fig. 1 and Fig. 10) on which is fastened the collar 291 abutting a projecting surface of lever 298 thereby moving it to the right and in doing so, adding tension to the spring 302 acting on the cam lever 288 which, however, does not move until at the start of the following coulier stroke when the narrowing machine lift cam 266 working through the roller 262, the lever 260, the shaft 200 and the vertical link pawls 270 acts to lift slightly the narrowing machine vertical motion levers 242 and rollers 246 from the plain discs 250 (Fig. 4), so that the spring-actuated cam lever 288 is permitted to force shift rod 258 to the right, thereby placing the narrowing machine roller 246 in line with the special cam 254 that controls the vertical position of the narrowing points during beard pressing. The shift rod 293 is locked in its shifted position by means of latch 295 which engages behind the stop collar 301 so that the collar and shift rod cannot return until a chain button lifts the latch at the completion of knitting of the heel gores.

The positioning of the narrowing points to and from the fixed press surface for beard pressing is also obtained from the movement to the right of the shift rod 258, the collar 344 abutting the lever 336 which in turn acts against a collar 342 on the back shift rod 334 (Figs. 1, 2, 3 and 10), moving it to the left. The shift rod 334 moves the cams 330, thereby moving the end of the lever 324 upward and rocking the shaft 206 to position the narrowing points rearwardly a small amount towards the fixed pressing surface.

The needle in-and-out motion cam roller 224 is moved to the right by shift rod 358 (Fig. 4) into alignment with the special cam 352. The shift rod 358 is held in this shifted position while knitting all the gores of the heel. A latch 306 with an abutment normally resting on the stop collar 310 falls so that the stop collar and shift rod cannot return to the left until the knitting of the heel gores is finished, at which time a chain button causes the lever 314, connected through a shaft to latch 306, to lift its latch portion and permit the shift rod to return to its normal position. Movement of the shift rod 358 to the right acts also through engagement of the collar 458 against the lever 454 to rotate the fabric take-up roll slightly counterclockwise (Fig. 5), in order to free the previously knit goods of take-up tension. The take-up tension remains off during the entire heel knitting operation until shift rod 358 is released from its latch and returned to its inoperative position.

For the knitting of the successively shorter courses of the heel gore, the narrowing point units are stepped outwardly one index simultaneously after the knitting of each successive course. This action is controlled by pattern actuated shift rods **586** and **568** above referred to, and takes place when the units are raised to a high position following the press.

The inner carrier stop units **790, 792** are moved outwardly two needle indexes in alternate courses, so that the yarn carriers forming the inner edges of the heel gores will stop always over a divider in accordance with the usual practice. For the formation of a continuously looped suture edge of the heel gore, in which no tucked loops are formed, in accordance with the form of applicant's method particularly described in Figs. 34 to 36 inclusive, a timing of the racking movement of the inner carrier spindle which is different from normal is employed to cause the carriers to be moved outwardly after the needles have drawn the loops off the noses of the sinkers. A rack of the pattern chain is employed to shift the cam control shift rod **842** to the right to shift the follower roller **838** (Fig. 5) onto cam **846** or onto cam **844** in the event that the method of inner edge formation of Figs. 34 to 36 is employed. A second shift rod, not specifically illustrated, controls the position of the in-and-out racking pawls **824** and **826**.

The outer carrier stops **936, 938, 944, 946**, shown in Fig. 29, are racked outwardly every four courses by two-needle indexes to periodically widen the fabric during the knitting of the first and second heel gores of Figs. 45 and 46, by connections controlled by the pattern shift rods **982** and **972**. Shift rod **982** controls the position of the in-and-out racking pawls **956, 958**, and the shifting of rod **972** causes the racking follower roller **966** to be shifted onto cam **968** so that the widening operation is performed in accordance with the form of applicant's method illustrated in Figs. 69 to 85 inclusive. This shift of roller **966** onto cam **968** is effected by the use of a bump on the pattern chain, and causes the racking movement of the outer carrier stop spindle **930** to take place as the needles move outwardly from the sinker means.

In the preferred form of the method of forming a widened selvage edge illustrated in Figs. 69 to 85 in dot-and-dash lines, and in Fig. 49, the outward movement of the yarn carrier at the selvage is accompanied by a slight outward rocking movement of the needles. A dip in the heel knitting needle press cam **352** is rendered operative to permit this outward movement of the needles by means of the pattern chain controlled connections including pattern shift rod **359** (Figs. 1 and 7), sleeve **355** on hand wheel shaft **357** which is moved from under restraining lever **353** on the presser shaft **196**.

Knitting of the first heel gore continues with the points stepping outwardly one index after loop forming in each cycle and with the carrier stops racking outwardly two indexes at intervals of every fourth course, or if so desired, every fifth course, the left hand heel being widened after a right to left coulier, and the right hand heel being widened after a left to right coulier.

Upon the completion of the last short course of the first right and left heel gores, a number of positioning operations take place preparatory to the knitting of the first long course of the second right and left heel gores. The narrowing point units are moved rapidly inwardly to a position determined by the intermediate length stops **632, 636** (see Fig. 7), the inner carrier stops are similarly positioned inwardly, and the heel knitting yarn carriers are correspondingly positioned to cooperate with the narrowing point units in their shifted position. Two alternative modes of operation of the machine have been illustrated for forming the first long course of the second and other succeeding heel gores.

In accordance with the form of the method of starting the second heel gore illustrated in Figs. 65 through 68 inclusive, the right and left heel gores are finished together, and the narrowing points are brought in simultaneously to start the new heel gore. The carrier stops are brought in by the rapid return motor before the right to left coulier so that the yarn from carrier **104** is laid to a group of needles inwardly of those covered by narrowing points. The yarn is kinked and knocked over to the front side of the needles, that is, to the side opposite the beards. This yarn during the following knitting motion of the needles will be drawn into the needle hooks, but as it is not connected by knitting with previous fabric loops held on the needle shanks, it will be cast off from the needles during the knitting of the next succeeding course without being connected into the fabric, and will then appear as float yarn (see right side of Fig. 67). After pressing the course in Fig. 65, the points are quickly brought in and positioned for the left to right coulier. This method produces a single course in the right hand heel without a tuck or reversing loop as shown in Fig. 66. On the following coulier, a tuck stitch is formed on the number 9 needle in the left hand heel, and in the next left to right coulier, a tuck stitch on the number 10 needle in the right hand heel.

In accordance with the alternative form of the method of starting the second heel gore illustrated in Figs. 30 to 32 inclusive, the machine is stopped after a right to left coulier, and the stop **673** (Fig. 4) is manually lowered, and the left hand narrowing points are then manually moved inwardly to cover the pre-selected needles while the right hand points are allowed to cover the needles for the last short course in the right hand heel. As soon as pressing is finished after the left to right coulier, the right hand points are moved in by the quick return motor to become synchronized with the left hand points. The stop is now manually lifted and latched until used at the start of the third gore.

This method may also be employed for the knitting of the first course of the first heel gore, the left hand narrowing point unit being brought in one course in advance of the right hand narrowing point unit which is held during the knitting of the first course in an inactive position outside the knitting gore.

The third gore is knitted as the first and second, except that the periodic selvage widening is discontinued during the knitting of this gore. The last heel course is couliered from right to left and pressed by the narrowing points. A chain button is racked in this cycle to lift the locks **306** and **295**, whereupon the several cam rollers are removed from alignment with their cams and returned to their normal positions for regular knitting. The machine is then stopped to enable the operator to inactivate one of the splicing carriers **108** in Fig. 61, and to put into operation the body carrier **100**. After the next coulier, from left to right, one of the right hand

splicing carriers 106 is inactivated and placed in an idle position. The course just laid was pressed using the regular stationary press surface. Knitting continues in the sole and lower instep portion of the stocking blank using the body carrier 100, the left hand splicing carrier 102 and the right hand splicing carrier 104. The carrier stops are manipulated as for regular knitting.

Features of the invention relating particularly to a full-fashioned hosiery blank having a novel and improved heel structure have been made the subject of a divisional application for United States Letters Patent filed for Max C. Miller, deceased, by Ida L. Miller, executrix, said divisional application having been executed on the 20th day of April, 1949 and forwarded to the Patent Office for filing on April 21, 1949.

The invention having been described, what is claimed is:

1. In a flat knitting machine, knitting instrumentalities including a series of spring beard needles movable as a unit, a narrowing machine having narrowing point units, needle knitting cams, narrowing machine vertical motion cams for moving the narrowing point units in accordance with a knitting cycle to close the beards of selected needles, and means operative between knitting cycles to shift said narrowing point units longitudinally of the needle series.

2. In a flat knitting machine, knitting instrumentalities including a series of spring beard needles movable as a unit, a narrowing machine having narrowing point units, operating means for moving the needles and narrowing point units in accordance with a loop transposing cycle of operation, operating means alternatively operable for moving the needles and narrowing point units in accordance with a knitting cycle of operation to cause the narrowing point units to close the beards of cooperating needles, and narrowing point unit shifting means including means operating between knitting cycles to shift said narrowing point units longitudinally of the needle series.

3. In a flat knitting machine, knitting instrumentalities including a series of spring beard needles movable as a unit, a narrowing machine having narrowing point units, operating means for moving the needles and narrowing point units in accordance with a knitting cycle of operations including means for moving the narrowing point units to close the beards of cooperating needles, and means operative between knitting cycles for effecting single needle outward indexing movements of the narrowing point units.

4. In a flat knitting machine, knitting instrumentalities including a series of spring beard needles movable as a unit, a narrowing machine having narrowing point units, operating means for moving the needles and narrowing point units in accordance with a knitting cycle of operations including means for moving the narrowing point units to close the beards of cooperating needles, narrowing point shifting means operative to shift the narrowing point units between knitting cycles including means for effecting single needle outward indexing movements of the narrowing point units for knitting outwardly on the needle series, and means for shifting the narrowing point units inwardly a plurality of needle indexes for knitting upon more inwardly disposed needles of the needle series.

5. In a flat knitting machine, knitting instrumentalities including a series of spring beard needles movable as a unit, a narrowing machine having narrowing point units, operating means for moving the needles and narrowing point units in accordance with a loop transposing cycle of operations, operating means for moving the needles and narrowing point units in accordance with a knitting cycle including means for moving the narrowing point units to close the beards of cooperating needles, and narrowing point unit shifting means for shifting the narrowing point units in accordance with loop transposing and knitting cycles including means for imparting a one-needle index outward shift, and selectively a relatively wide inward shift to the narrowing point units between knitting cycles for knitting upon more outwardly and more inwardly disposed groups of knitting needles respectively.

6. In a flat knitting machine, knitting instrumentalities including a series of spring beard needles movable as a unit, a narrowing machine having narrowing point units, operating means for moving the needles and narrowing point units in accordance with a loop transposing cycle of operations, operating means for moving the needles and narrowing point units in accordance with a knitting cycle including means for moving the narrowing point units to close the beards of cooperating needles, narrowing point unit shifting means including means for shifting said narrowing point units longitudinally of the needle series in accordance with a loop transposing cycle, and means for shifting said narrowing point units longitudinally of the needles between successive said knitting cycles, and pattern means for controlling said narrowing point unit shifting means.

7. In a flat knitting machine, knitting instrumentalities including a series of spring beard needles movable as a unit, and means for pressing the needle beards, a narrowing machine having narrowing point units comprising points arranged to cooperate with groups of needls at each end of the needle series, operating cams for the needles and operating cams for the narrowing point units for moving the needles in accordance with a knitting cycle in which said pressing means are inoperative, and for moving the narrowing point units with relation to the needles to close the beards only of those needles cooperating with said narrowing point units, and narrowing point shifting means for shifting the narrowing point units longitudinally of the needle series to close the beards of selected numbers of needles of the end groups, and pattern means controlling the operation of said operating means and of said shifting means.

8. In a flat knitting machine, knitting instrumentalities including a series of spring beard needles movable as a unit, and means for pressing the beards of the needles, a narrowing machine having narrowing point units, means for shifting the narrowing point units forward and back on the frame between narrowing and beard closing knitting positions, and operating means for moving the needles and the narrowing point units therewith in accordance with a knitting cycle to cause the needle beards only of those needles engaged by said narrowing point units to be closed.

9. In a flat knitting machine, knitting instrumentalities including a series of spring beard needles movable as a unit, and means for pressing the needle beards, needle beard closing units comprising series of beard closing elements ar-

ranged to cooperate with groups of needles at each end of the needle series and movable longitudinally of the needle shanks to and from the beard closing needle press position, vertical press motion knitting cam means for said units, knitting motion cam means for the needles arranged to move the needles to a beard closing needle press position with respect to said needle beard closing elements, and means for shifting the beard pressing units longitudinally of the needle series to close the beards only of selected numbers of needles of the end groups.

10. In a flat knitting machine, knitting instrumentalities including a series of spring beard needles movable as a unit, and means for pressing the needle beards, a pair of needle beard closing units comprising series of beard closing elements arranged to cooperate with groups of needles at each end of the needle series and movable longitudinally of the needle shanks to and from the beard closing needle press position, knitting press motion cam means for said units, knitting motion cam means for operating the needles in accordance with the knitting cycle and in combination with said needle beard closing elements to close the beards only of those needles engaged by said elements, means for indexing said needle pressing units longitudinally of the needle series to close the beards of a variable selected number of needles of the end groups, yarn feeding means including yarn carriers and inner carrier stops, and means for indexing said inner carrier stops to feed yarn inwardly only to said selected numbers of needles of the end groups.

11. In a flat knitting machine, knitting instrumentalities including a series of spring beard needles movable as a unit, and means for pressing the needle beards, a pair of needle beard closing units comprising groups of beard closing elements arranged to cooperate with groups of needles at each end of the needle series and movable longitudinally of the needle shanks to and from the beard closing needle press position, operating means for the needle beard closing units, and operating means for the needles arranged to move the units and needles in accordance with a knitting cycle to cause only those needle beards to close which are engaged by the beard covering closing elements of the respective needle beard closing units, means for shifting said needle beard closing units longitudinally of the needle series to close the beards of a selected number of needles of the end groups, yarn feeding means including yarn carriers and inner carrier stops, means for shifting said inner carrier stops to feed yarn only to said selected numbers of needles of the end groups, and pattern means for controlling both of said shifting means for the knitting of shaped heel fabrics.

12. In a flat knitting machine, knitting instrumentalities including a series of spring beard needles movable as a unit, and means for pressing the needle beards, a narrowing machine having narrowing point units arranged to cooperate with groups of needles at each end of the needle series, operating means for the narrowing point units and needles arranged to operated said units and needles in accordance with a narrowing cycle of operation, operating means for the narrowing point units and needles arranged to operate the units and needles in accordance with a knitting cycle to cause only those needle beards to close which are engaged by the points of the respective narrowing point units, yarn feeding mechanism including yarn carriers for feeding yarn to said

end groups of needles and inner carrier stops associated therewith, and shifting means for shifting the narrowing point units in accordance with loop transposing and knitting cycles of operation including racking devices for producing a one-needle outward indexing movement, shifting means for the inner carrier stops including racking means for producing a two-needle index outward racking movement thereof, and pattern means controlling the operation of said indexing devices.

13. In a flat knitting machine, knitting instrumentalities including a series of spring beard needles movable as a unit, and means for pressing the needle beards, a narrowing machine having narrowing point units, operating means for the narrowing point units and needles arranged to operate said units and needles in accordance with a narrowing cycle of operation, operating means for the narrowing point units and needles arranged to operate the units and needles in accordance with a knitting cycle to cause only those needle beards to close which are engaged by the points of the respective narrowing point units, and shifting means for shifting the narrowing point units in accordance with loop transposing and knitting cycles of operation including racking devices for producing a one-needle outward indexing movement between successive courses, and auxiliary means operable to effect a relatively wide inward unit shifting movement between successive courses.

14. In a flat knitting machine, knitting instrumentalities including a series of spring beard needles movable as a unit, and means for pressing the needle beards, a narrowing machine having narrowing point units, operating means for the narrowing point units and needles arranged to operate said units and needles in accordance with a narrowing cycle of operation, operating means for the narrowing point units and needles arranged to operate the units and needles in accordance with a knitting cycle to cause only those needle beards to close which are engaged by the points of the respective narrowing point units, shifting means for shifting the narrowing point units in accordance with loop transposing and knitting cycles of operation including racking devices for producing a one-needle outward indexing movement between successive courses, and auxiliary means operable to effect a relatively wide inward unit shifting movement between successive courses, and pattern means for effecting any of said shifting movements.

15. In a flat knitting machine, knitting instrumentalities including a series of spring beard needles movable as a unit, and means for pressing the needle beards, a narrowing machine having narrowing point units arranged to cooperate with end groups of needles of the needle series, operating means for the narrowing point units, and operating means for the needles arranged to operate said needles and units in accordance with a knitting cycle to cause only those needle beards to close which are engaged by the points of the respective narrowing point units, yarn feeding devices including yarn carriers and inner carrier stops for causing the carriers to feed yarn only to said end groups of needles, shifting means for the narrowing point units including means for effecting successive one-needle index outward racking movements of said units in each successive course of a series, and shifting means for the inner carrier stops arranged to produce a

two-needle index outward racking movement thereof in each alternate course of the series.

16. In a flat knitting machine, knitting instrumentalities including a series of spring beard needles movable as a unit, a cam shaft, a narrowing machine including narrowing point units, operating means comprising narrowing machine vertical motion narrowing and knitting cams selectively operable for moving the point units in a loop transposing cycle and alternatively in accordance with a knitting cycle to close the needle beards and a follower roller shiftable with respect to said cams, a narrowing cam shaft shift mechanism, a narrowing machine lift cam and a follower roller shiftable with respect thereto, and means for rendering said lift cam and follower roller operative to facilitate the shaft of said vertical motion cam follower roller onto said knitting cam.

17. In a flat knitting machine, knitting instrumentalities including a series of spring beard needles movable as a unit, a narrowing machine including narrowing point units, operating means comprising narrowing machine vertical cams and a follower roller shiftable with respect to said cams, a narrowing machine lift cam and a follower roller shiftable with respect thereto, a pattern chain, and follower connections therefrom including a shift rod for shifting said operating cam follower roller, and connections including a shift rod controlled by said chain for rendering said lift cam and follower connection operative to facilitate the shift of said vertical motion cam follower roller.

18. In a flat knitting machine, knitting instrumentalities including spring beard needles movable as a unit, and means for pressing the needle beards, a narrowing machine having narrowing point units, operating cams for operating the narrowing point units and needles in accordance with alternative narrowing and knitting cycles of operation including narrowing machine vertical motion idling, narrowing and knitting cams, follower connections including a follower roller shiftable from the idler onto the knitting cam, a narrowing machine lift cam and a follower roller shiftable with relation thereto, means for shifting the narrowing machine follower roller onto its knitting cam, and means associated with said shifting means for moving said lift cam follower roller onto its cam to permit the shifting of said operating roller.

19. In a flat knitting machine, knitting instrumentalities including spring beard needles movable as a unit, and means for pressing the needle beards, a narrowing machine providing narrowing point units shiftable between alternative forward and back positions, which comprises a rearwardly disposed narrowing machine fulcrum shaft, a series of forwardly extending supporting levers secured to the shaft, a forwardly disposed narrowing point unit supporting shaft supported for rocking movement on said supporting levers, right and left narrowing point units including supporting brackets therefor secured to said supporting shaft, a shifting lever secured to the supporting shaft, and cam means axially shiftable on the fulcrum shaft engaging with said shifting lever for rocking the lever and supporting shaft from one to another of two alternative positions.

20. In a flat knitting machine, knitting instrumentalities including a series of spring beard needles movable as a unit, and means for closing the needle beards, a narrowing machine having left and right narrowing point units for engagement with left and right end groups of needles of the needle series, means for shifting the narrowing point units forward and back between a narrowing position and a knitting beard closing position, operating means for the narrowing point units and for the needles arranged to operate said units and needles in accordance with alternative narrowing and knitting cycles of operation, yarn feeding means comprising yarn carriers and inner carrier stops, racking means for indexing the narrowing point units to close the beards of different numbers of needles, racking means for indexing the inner carrier stops to cause the carriers to feed yarn only to said numbers of end needles cooperating with the narrowing point units, and pattern means for controlling each of the narrowing point forward and back shifting means, the operating means, the narrowing point unit racking means, and the carrier inner stop racking means in timed relation.

21. In a flat knitting machine, knitting instrumentalities including a series of needles movable as a unit, a device adapted to be shifted longitudinally of the needle series, a driving mechanism for the machine including a cam shaft, a shifting mechanism comprising a threaded spindle, a nut engaging therewith, racking means driven from the cam shaft for imparting relative movement of the spindle and nut for indexing said device with respect to the needles of the series, and auxiliary power means for effecting a rapid relative movement of the nut and spindle to shift said device a relatively large number of needle indexes in less than one revolution of said cam shaft.

22. In a flat knitting machine, knitting instrumentalities including a series of needles movable as a unit, a device adapted to be shifted longitudinally of the needle series, a driving mechanism for the machine including a cam shaft, a shifting mechanism comprising a threaded spindle, a nut engaging therewith, racking means actuated from the cam shaft for imparting relative movement of the spindle and nut for indexing said device with respect to the needles of the series, auxiliary power means for effecting a rapid relative movement of the nut and spindle to shift said device a relatively large number of needle indexes during a part revolution of said cam shaft, and pattern means for initiating said rapid movement of the nut and spindle by said auxiliary power means.

23. In a flat knitting machine, knitting instrumentalities including a series of needles movable as a unit, a device shiftable longitudinally of the needle series, a screw-threaded spindle and a nut for shifting said device, racking means comprising a ratchet and pawl to provide relative movement between the spindle and nut for indexing said device with respect to the needles, an auxiliary shifting device comprising a stallable electric motor connected for actuating said spindle and nut for effecting rapid movement of said device over a relatively large number of needle indexes, and a stop for limiting said rapid movement of the device.

24. In a flat knitting machine, knitting instrumentalities including a series of needles movable as a unit, a device shiftable longitudinally of the needle series, a screw-threaded spindle and nut for shifting said device, pawl and ratchet rack-

ing means to provide relative movement between the spindle and nut for indexing said device with respect to the needles of the series, auxiliary power means for actuating the spindle and nut to effect rapid movement of the device over a relatively large number of needle indexes, a stop for limiting said rapid movement of the device under the influence of said power means, and control means acting when rendered operative to initiate said rapid movement and upon completion thereof to actuate said racking means for accurately indexing said device with respect to the needles of the series.

25. In a flat knitting machine, knitting instrumentalities including a series of needles movable as a unit, a device shiftable longitudinally of the needle series, a screw-threaded spindle and a nut for shifting said device, racking means comprising a ratchet and pawl to provide relative movement between the spindle and nut for indexing said device with respect to the needles, an auxiliary shifting device comprising a stallable electric motor connected for actuating said spindle and nut for effecting rapid movement of said device over a relatively large number of needle indexes, a stop for limiting said rapid movement of the device, and pattern actuated connections including a switch actuable to initiate operation of said motor, connections controlled by the pattern chain for subsequently disengaging said motor and for actuating said racking means to index said device accurately with relation to the needles at the end of said rapid movement.

26. In a flat knitting machine, knitting instrumentalities including a series of needles movable as a unit, a narrowing machine having narrowing point units, operating means for moving the needles and narrowing point units with relation thereto in accordance with alternative narrowing and knitting cycles of operation, a screw-threaded spindle and nuts for shifting said narrowing point units longitudinally of the needle series, ratchet and pawl racking means for the spindle, auxiliary power means for actuating the spindle to effect rapid movement of the narrowing point units inwardly for a relatively large number of needle indexes, a stop for limiting said rapid movement of said units, a pattern chain, means controlled thereby for actuating said racking means in timed relation with the narrowing cycle of operation of the needles and narrowing point units, means actuated by the pattern chain for actuating said racking means in timed relation between successive knitting cycles of operation of said needles and narrowing point units, and means controlled by the pattern chain for initiating the operation of said auxiliary power means in timed relation between said knitting cycles of operation.

27. In a flat knitting machine, knitting instrumentalities including a series of spring beard needles movable as a unit, a narrowing machine having narrowing point units arranged to cooperate with left and right heel groups of needles of the series, narrowing point unit shifting means comprising a threaded spindle and nuts acting upon each of said units, pawl and ratchet racking means for the spindle, a stallable electric motor for driving the spindle to effect a rapid inward movement of the units, an auxiliary shaft, a plurality of stops carried by the auxiliary shaft and rendered alternatively operable by rotation of the shaft to arrest rapid inward movement of the narrowing point units, a motor circuit including a switch, and means responsive to rotation of said auxiliary shaft to control the switch, a pattern chain, a second switch in series with the first switch in said circuit, a pattern chain actuated shift rod and connections therefrom for rotating said auxiliary shaft to operatively position a stop and to close said first switch, a second pattern chain shift rod and connections controlled thereby for actuating said second switch.

28. In a flat knitting machine, knitting instrumentalities including a series of spring beard needles movable as a unit, a narrowing machine consisting of a longitudinally extending fulcrum shaft, forwardly extending arms secured thereto, a longitudinally extending rock shaft carried in the forward ends of said arms, a series of depending supports on said rock shaft, narrowing point unit rods and narrowing point units carried in said supports, and means for rocking said shaft between two alternative predetermined positions comprising rearwardly extending cam follower elements secured to the rock shaft and cams engaging therewith axially shiftable on the fulcrum shaft.

29. In a flat knitting machine, knitting instrumentalities including a series of spring beard needles movable as a unit, a narrowing machine consisting of a longitudinally extending fulcrum shaft, forwardly extending arms secured thereto, a longitudinally extending rock shaft carried in the forward ends of said arms, a series of depending supports on said rock shaft, narrowing point unit rods and narrowing point units carried in said supports, and means for rocking said shaft between two alternative predetermined positions comprising rearwardly extending arms secured to the rock shaft, a cam sleeve axially shiftable on the fulcrum shaft, cooperating cam and follower surfaces on the cam sleeve and rearwardly extending arms for positively positioning the rock shaft in either of two positions, a pattern chain, and connections from the pattern chain for shifting said cam sleeve from one to the other position.

30. In a flat knitting machine, knitting instrumentalities including a series of spring beard needles movable as a unit, a narrowing machine having narrowing point units cooperating with the left and right groups of needles of the needle series, operating means for moving the needles and narrowing point units therewith in accordance with a knitting cycle to cause the narrowing point units to close the beards of cooperating needles for the knitting of heel courses and without pressing the beards of intermediate instep course needles for the knitting of heel fabrics, racking mechanism comprising a screw-threaded spindle and nuts engaging said narrowing point units for moving them positively inwardly, spring means for maintaining engagement of the narrowing point units with their nuts, pawl and ratchet mechanism for rotating the spindle, auxiliary power means for rotating the spindle to effect a rapid inward movement of the nuts and narrowing point units engaged thereby, stops for limiting said inward movement of the left and right narrowing point units respectively, and latching means to support one of said narrowing point units in a relatively inward position prior to the initiation of said rapid inward movement.

31. In a flat knitting machine, knitting instrumentalities including a series of spring beard needles movable as a unit, a narrowing machine having narrowing point units cooperating with the left and right groups of needles of the needle series, operating means for moving the needles

and narrowing point units therewith in accordance with a knitting cycle to cause the narrowing point units to close the beards of cooperating needles for the knitting of heel courses and without pressing the beards of intermediate instep course needles, racking mechanism comprising a screw-threaded spindle and nuts engaging said narrowing point units for moving them positively inwardly, spring means for maintaining the units in engagement with the respective nuts, and a latch for supporting one of said narrowing point units in a relatively inward position while said nuts and the other of said narrowing point units controlled thereby remain in a relatively outward position.

32. In a flat knitting machine, knitting instrumentalities including a series of spring beard needles movable as a unit, a narrowing machine having narrowing point units cooperating with left and right groups of needles of the needle series, operating means for moving the needles and the narrowing point units therewith in accordance with a knitting cycle to cause the narrowing point units to close the beards of said left and right groups of needles respectively and without pressing the beards of the intermediate instep group of needles for the knitting of heel fabric, left and right heel knitting yarn carriers traversable for feeding yarn only to said end groups of needles, inner carrier stops and outer carrier stops for limiting the traverse of said left and right heel yarn carriers, and pattern controlled positioning mechanism for the shaping of the heel fabrics comprising a pattern chain and connections controlled therefrom for moving the narrowing point units rapidly inwardly, and thereafter for stepping the narrowing point units outwardly one needle index for the knitting of each successive course in the knitting of the heel gore, locating the inner carrier stops to feed yarn inwardly to the needles engaged by said narrowing point units, and thereafter for stepping said inner carrier stops outwardly two new needle indexes on alternate courses, and means for stepping the outer carrier stops outwardly two needle indexes during the knitting of selected heel courses for the widening of the heel fabric.

33. In a flat knitting machine having a series of spring beard needles movable as a unit, yarn measuring sinkers and dividers alternating with the sinkers, and means for pressing the beards of the needles, a narrowing machine comprising a vertically movable frame and narrowing point units carried on the frame, operating means including a cam shaft, cam and follower connections for operating each of said needles and narrowing machine in accordance with a heel knitting cycle of operation to cause the narrowing units to close the beards of cooperating needles, and without pressing the beards of the intermediate instep needles, yarn feeding means including reciprocatory yarn carriers and inner and outer carrier stops, racking means for each of the narrowing point units, the inner carrier stops and the outer carrier stops, a pattern chain, connections controlled from the chain for rendering said cam and follower connections operative to condition the narrowing machine and needles for heel knitting, latching means for maintaining said parts in operative position, and means controlled by the pattern chain for releasing the latch, and additional connections from the pattern chain for controlling each of said narrowing point units and inner and outer carrier stops in accordance with the heel knitting cycle of operation.

34. In a flat knitting machine, instrumentalities including a series of spring beard needles movable as a unit and means for pressing the needle beards, a narrowing machine having narrowing point units adapted for use as beard closing elements, operating means for the needles and units arranged for the knitting of heel fabrics while holding terminal loops of the instep fabric wales on intermediate needles, yarn feeding devices including reciprocating yarn carriers, outer carrier stops and inner carrier stops for causing the carriers to feed yarn to said heel and knitting needles, means for stepping the narrowing point units outwardly one needle index for each successive course of a series, and means for stepping said inner carrier stops outwardly two needle indexes to move the carrier outwardly with the needles at the knockover and with the sinkers and dividers substantially retracted whereby the yarn leading from the inner reversing loop is disposed outwardly of the reversing needle to provide a single full loop of yarn about the reversing needle, and a full loop upon the next outwardly disposed needle from the reversing needle upon the knitting of the return of the course.

35. In a flat knitting machine having a series of spring beard needles movable as a unit, yarn measuring sinkers and dividers alternating with the sinkers, and means for pressing the beards of the needles, a narrowing machine comprising a frame, and narrowing point units supported thereon for vertical movement with the frame and rocking movement relatively thereto, means including cam and follower connections for shifting the narrowing point units forward and back on the frame between narrowing and beard closing knitting positions, operating means including a needle press cam, needle vertical motion knitting and heel knitting cams, and a needle vertical motion follower roller, narrowing machine vertical motion cams including narrowing and knitting cams and a follower roller therefor, racking means for said narrowing point unit, yarn feeding means including yarn carriers reciprocable to form heel courses, inner and outer carrier stops and racking means for said stops, and a pattern chain and connections controlled from the chain for shifting each of said narrowing point unit racking cam and follower connections, the needle vertical motion follower roller, and narrowing machine vertical motion follower roller to a heel knitting position, and connections from the pattern chain operative for conditioning each of said racking means to produce heel courses successively shortened at their inner ends to form heel gores.

36. In a flat knitting machine having a series of spring beard needles movable as a unit, means for pressing the needle beards and individually movable yarn measuring sinkers, the combination of a series of nibbed knockover bits, supporting means on which the knockover bits are capable of forward and back movement, resilient means supporting the knockover bits forwardly to cause the newly formed sinker wale kinks as they are drawn from the sinker noses to be engaged in and held by the knockover bit nibs to the backs of the needles during the rearward knocking over and early rising movements of the needles, and means acting to positively retract the nibbed knockover bits to maintain the nibbed portions thereof inoperative during the continued rising

movements of the needles and the subsequent yarn measuring and needle beard pressing movements of the sinkers and needles.

37. In a flat knitting machine having a series of spring beard needles movable as a unit, means for pressing the needle beards and individually movable yarn measuring sinkers, the combination of a series of nibbed knockover bits, supporting means on which the knockover bits are capable of forward and back movement, resilient means urging the knockover bits forwardly, stop means for limiting said forward movement of the knockover bits in a position to cause the sinker wale kinks as they are drawn from the sinker noses to be engaged in and resiliently held by the knockover bit nibs to the backs of the needles during the rearward knocking over and early rising movements of the needles, and means normally acting to position the knockover bits with the nibbed portions thereof in a rearward inoperative position operable to permit movement of the knockover bits to the forward position only during said rearward knocking over and early rising movements of the needles.

38. In a flat knitting machine having a series of spring beard needles movable as a unit, means for pressing the needle beards, and individually movable yarn measuring sinkers, the combination of a series of nibbed knockover bits, supporting means on which the knockover bits are capable of vertical and forward and back movement, means for controlling the vertical position of the knockover bits including a vertical stop, and resilient means for supporting the knockover bits yieldably upwardly against said stop, resilient means urging the knockover bits forwardly, stop means for limiting said forward movement of the knockover bits in a position to cause the sinker wale kinks to be engaged in and resiliently held by the knockover bits to the backs of the needles during the rearward knocking over and early rising movements of the needles, and means normally acting to position the knockover bits with the nibbed portions thereof in a rearward inoperative position operable to permit movement of the knockover bits to the forward position only during said rearward knocking over and early rising movements of the needles.

39. In a flat knitting machine having a series of spring beard needles movable as a unit, means for pressing the needle beards, and individually movable yarn measuring sinkers, the combination of a series of nibbed knockover bits, supporting means on which the knockover bits are capable of forward and back movement, resilient means urging the knockover bits forwardly, stop means for limiting said forward movement of the knockover bits in a position to cause the sinker wale kinks to be engaged in and resiliently held by the knockover bit nibs to the backs of the needles during the rearward knocking over and early rising movements of the needles, means for positioning the knockover bits rearwardly to disengage the nibbed portions thereof from the fabric, a cam shaft, actuating connections from the cam shaft for operating the needles, and actuating connections from the cam shaft for actuating said knockover bit retracting means.

40. In a flat knitting machine having a series of spring beard needles movable as a unit, means for pressing the needle beards, and individually movable yarn measuring sinkers, the combination of a series of nibbed knockover bits, a knockover bit supporting assembly comprising a slotted knockover bit bar, vertically arranged supporting arms for the bar mounted to permit limited vertical and forward and back movements thereof, means for controlling the vertical position of the knockover bits including resilient means urging the bar upwardly and forwardly, and stop means for limiting upward movement of the knockover bits at the knockover level, and stop means acting on the knockover bit supporting assembly closely adjacent the knockover level to limit forward movement of the knockover bits.

41. In a flat knitting machine having a series of spring beard needles movable as a unit, means for pressing the needle beards, and individually movable yarn measuring sinkers, the combination of a series of nibbed knockover bits, a knockover bit supporting assembly comprising a slotted knockover bit bar, vertically arranged supporting arms for the bar mounted to permit limited vertical and forward and back movements thereof, means for controlling the vertical position of the knockover bits including a vertical stop and spring means acting on the knockover bit assembly to maintain the knockover bits yieldingly at the knockover level against said stop, spring means urging the knockover bit assembly in a forward direction, and cam means acting on the knockover bit assembly to limit forward movement thereof and shiftable to provide two alternative limiting forward positions of the knockover bits.

42. In a flat knitting machine having knitting instrumentalities including a series of spring beard needles movable as a unit, means for pressing the needle beards, and individually movable yarn measuring sinkers, and a narrowing mechanism comprising narrowing point units, the combination of a series of nibbed knockover bits, supporting means on which the nibbed knockover bits are capable of forward and back movement, resilient means urging the knockover bits forwardly, stop means for limiting said forward movement of the knockover bits in a position to cause the sinker wale kinks as they are drawn from the sinker noses to be engaged in and resiliently held by said nibs to the backs of the needles during the rearward knocking-over movement of the needles, means for operating said knitting instrumentalities in accordance with a knitting cycle including means for positively retracting the nibbed knockover bits during a portion of each cycle, and means for operating said instrumentalities and narrowing mechanism in accordance with a narrowing cycle of operation including means for positively retracting said knockover bits during the narrowing motions.

43. In a flat knitting machine having knitting instrumentalities including a series of spring beard needles movable as a unit, means for pressing the needle beards, and individually movable yarn measuring sinkers, and a narrowing mechanism comprising narrowing point units, the combination of a series of nibbed knockover bits, supporting means on which the nibbed knockover bits are capable of forward and back movement, resilient means urging the knockover bits forwardly, stop means for limiting said forward movement of the knockover bits in a position to cause the sinker wale kinks as they are drawn from the sinker noses to be engaged in and resiliently held by the knockover bits to the backs of the needles during the rearward knocking-over movement of the needles, and means for operating the knitting instrumentalities in accordance with a kniting cycle for the knitting of full

courses, and means for operating the knitting instrumentalities and narrowing point units in accordance with a heel knitting cycle including means for retracting the knockover bits from said forward limiting position during the yarn measuring and needle beard pressing movements of the sinkers and needles.

44. In a flat knitting machine having knitting instrumentalities including a series of spring beard needles movable as a unit, means for pressing the needle beards, and individually movable yarn measuring sinkers, and a narrowing mechanism comprising narrowing point units, the combination of a series of nibbed knockover bits, supporting means on which the nibbed knockover bits are capable of forward and back movement, resilient means urging the knockover bits forwardly, stop means for limiting said forward movement of the knockover bits in a position to cause the sinker wale kinks as they are drawn from the sinker noses to be engaged in and resiliently held by the knockover bits to the backs of the needles during the rearward knocking-over movement of the needles, means for operating the knitting instrumentalities in accordance with a knitting cycle for the knitting of full courses, and means for operating the knitting instrumentalities and narrowing point units in accordance with a heel knitting cycle, including means operable with each of said cycles for retracting the knockover bits from said forward limiting position during the yarn measuring and needle beard pressing movements of the sinkers and needles, and means for operating said instrumentalities and narrowing mechanism in accordance with a narrowing cycle of operation including means for positively retracting said knockover bits during the narrowing cycle.

45. In a flat knitting machine having knitting instrumentalities including a series of spring beard needles movable as a unit, means for pressing the needle beards, and individually movable yarn measuring sinkers, and a narrowing mechanism comprising narrowing point units, the combination of a series of nibbed knockover bits, supporting means on which the nibbed knockover bits are capable of forward and back movement, resilient means urging the knockover bits forwardly, stop means for limiting said forward movement of the knockover bits in a position to cause the sinker wale kinks as they are drawn from the sinker noses to be engaged in and resiliently held by the knockover bits to the backs of the needles during the rearward knocking-over movement of the needles, means for operating said knitting instrumentalities and narrowing mechanism in accordance with a narrowing cycle of operation, and means acting in timed relation to said narrowing cycle for positively moving the knockover bits rearwardly to position the nibs in a withdrawn inoperative position.

46. In a multiple section flat knitting machine having for each knitting section, knitting instrumentalities operable in accordance with a knitting cycle of operation including a series of spring beard needles movable as a unit, means for pressing the needle beards, and individually movable yarn measuring sinkers, the combination of nibbed knockover bits and a slotted knockover bit supporting bar for each knitting section, supporting means on which each knockover bit bar is capable of forward and back movement, resilient means urging the knockover bit bar forwardly, stop means for limiting said forward movement of the knockover bits in a position to cause the sinker wale kinks as they are drawn from the sinker noses to be engaged in and resiliently held by the knockover bits to the backs of the needles during the rearward knocking-over movements of the needles, an actuating bar extending along the length of a plurality of the knitting sections, and cam means controlled by said bar for retracting the associated knockover bit bars to place the knockover bit nibs in a retracted inoperative position.

47. In a multiple section flat knitting machine having for each knitting section, knitting instrumentalities operable in accordance with a knitting cycle of operation including a series of spring beard needles movable as a unit, means for pressing the needle beards, and individually movable yarn measuring sinkers, the combination of nibbed knockover bits and a slotted supporting knockover bit bar for each knitting section, supporting means on which each knockover bit bar is capable of forward and back movement, resilient means urging the knockover bit bar forwardly, stop means for limiting said forward movement of the knockover bits in a position to cause the sinker wale kinks as they are drawn from the sinker noses to be engaged in and resiliently held by the knockover bits to the backs of the needles during the rearward knocking-over movements of the needles, a control bar extending along the length of a plurality of the knitting sections, cam means actuated by said bar for moving the knockover bit bars to position the nibs thereof in a retracted inoperative position, and means acting during a portion of each knitting cycle for moving the bar to retract the knockover bit bars.

48. In a flat knitting machine, a machine frame, knitting instrumentalities including a series of needles movable as a unit, nibbed knockover bits, a slotted bar in which the knockover bits are rigidly held, supporting means on which the bar is supported to move freely forward and back, spring means to urge the knockover bit bar forwardly, and stop means carried on the machine frame acting on said bar adjacent the fabric level for limiting said forward movement.

49. In a flat knitting machine, a machine frame, knitting instrumentalities including a series of needles movable as a unit, nibbed knockover bits, a slotted bar in which the knockover bits are rigidly held, supporting means on which the bar is supported to move freely forward and back, spring means to urge the knockover bit bar forwardly, stop means carried on the machine frame for limiting the yieldable advance of the knockover bit bar to either of two predetermined advanced positions, and means timed with relation to the needle movement to render said stop means operative to position the knockover bit bar in first one and then the other of said positions.

50. In a flat knitting machine, a machine frame, a series of needles movable as a unit, yarn measuring sinkers, nibbed knockover bits, a knockover bit bar, supporting means on which the bar is supported to move freely forward and back, spring means to urge the knockover bit bar forwardly, and positioning means comprising two stepped cam and follower elements carried on the bar and frame respectively, and means for relatively moving said cam and follower elements to provide alternative limiting advanced positions of said bar.

51. In a multiple section flat knitting machine, a machine frame, series of needles movable as a unit, yarn measuring sinkers, nibbed knockover bits, an individual knockover bit bar for each knitting section, supporting means on which each knockover bit bar is supported to move freely forward and back, spring means to urge each knockover bit bar forwardly, and positioning means comprising an axially shiftable control bar extending longitudinally of a plurality of knitting sections, and two stepped cam and follower elements carried by the several knockover bit bars and control bar respectively rendered operative by axial movement of the control bar for supporting the knockover bit bars alternatively in either of two advanced positions.

52. In a multiple section flat knitting machine, a machine frame, a series of needles movable as a unit, yarn measuring sinkers, nibbed knockover bits, an individual knockover bit bar for each knitting section, supporting means on which each knockover bit bar is supported to move freely forward and back, spring means to urge each knockover bit bar forwardly, and positioning means comprising an axially shiftable control bar extending longitudinally of a plurality of knitting sections, cam and follower elements carried by the several knockover bit bars and control bar respectively arranged for alternative axially adjusted positions of the control bar to provide two advanced positions of said knockover bit bars, and means acting in timed relation with the movement of the needles for shifting said control bar.

53. In a flat knitting machine having a series of needles movable as a unit, successively projected yarn measuring sinkers, and dividers arranged to be advanced as a unit alternating with the sinkers, a yarn carrier, and traversing means for the carrier, an outer carrier stop arranged to stop carrier traverse over any selected divider, and control means for knitting a widened selvage fabric comprising indexing means for the carrier stop to shift the stop outwardly after the stop has acted to stop the carrier at the selvage and after the next sinker outwardly considered from the selvage has completed its yarn measuring movement, thereby to permit movement of the carrier two needle indexes outwardly to stand over the next more outwardly disposed divider, and means associated with said stop indexing means to rock the needles outwardly to an abnormal extent as the newly formed loops are drawn off the sinker noses to cause the length of yarn extending from the last completed selvage loop to the carrier to be placed beneath the divider over which the carrier has previously stood.

54. In a flat knitting machine, knitting instrumentalities including a series of needles movable as a unit, yarn measuring sinkers and dividers alternating with the sinkers, a yarn carrier, an outer carrier stop, operating means including a cam shaft, indexing means for shifting the stop outwardly for heel widening including a cam and follower connection to shift the stop outwardly after the stop has acted to stop the carrier at the selvage and after the next sinker outwardly considered from the selvage has completed its yarn measuring movement to permit movement of the carrier two needle indexes outwardly to stand over the next outwardly disposed divider, needle operating means including a heel knitting needle press cam having a dip to permit an abnormal outward rocking movement of the needle at the knockover, stop means normally operative to prevent said abnormal outward movement, and control means acting on said stop means to permit said abnormal outward movement of the needles with relation to thread stop indexing means for widening.

55. In a flat knitting machine, operating means including a cam shaft, knitting instrumentalities including a series of needles movable as a unit, yarn measuring sinkers and dividers alternating with the sinkers, a traversable yarn carrier, an outer carrier stop arranged to stop carrier traverse over any selected divider, and needle vertical and press motion connections including a needle vertical motion cam, a needle press cam, a heel knitting needle press cam having a dip to permit of an abnormal outward rocking movement of the needles to knockover, a stop member associated with the needle press motion connections operative to prevent said abnormal outward movement of the needles, and pattern control means moving said stop member to permit said abnormal needle rocking movement.

56. In a flat knitting machine, knitting instrumentalities including a series of spring beard needles movable as a unit, yarn measuring sinkers and dividers alternating therewith, a pair of needle beard closing units each comprising a group of beard closing elements, operating means for the needles and units arranged for the knitting of heel fabrics upon needles cooperating with said units while holding terminal loops of the instep fabric wales on intermediate needles, yarn carriers reciprocating to form heel courses, and control means including means for stepping said units outwardly one needle index with each course, inner carrier stops arranged to stop inward carrier movement over the next divider inwardly disposed from the innermost active needles cooperating with said units, and means for stepping said stops outwardly two needle indexes to stand over the next divider outwardly, said stepping movement being timed to take place subsequent to the inward traverse of the associated carrier with the needles at the knockover and with the sinkers retracted.

57. In a flat knitting machine, knitting instrumentalities including a series of spring beard needles movable as a unit and means for pressing the needle beards, a pair of needle beard closing units comprising a series of beard closing elements arranged to cooperate with groups of needles at each end of the needle series, operating means, means for conditioning the said units and needles for operation by the operating means in accordance with a knitting cycle of operation to knit upon end groups of the needles while the intermediate needles retain their loops, heel knitting yarn carriers, inner carrier stops, means for stepping the units and inner carrying stops, outwardly for the knitting of the successively shortened courses of a heel gore, and thereafter between successive courses moving both said units and carrier stops inwardly a substantial number of needle indexes for the knitting of the first long course of the next succeeding gore.

58. In a flat knitting machine, knitting instrumentalities including a series of spring beard needles movable as a unit and means for pressing the needle beards, a pair of needle beard closing units comprising a series of beard closing elements arranged to cooperate with groups of needles at each end of the needle series, opera-

ting means, means for conditioning the said units and needles for operation by the operating means in accordance with a knitting cycle of operation to knit upon end groups of the needles while the intermediate needles retain their loops, heel knitting yarn carriers, inner carrier stops, means for stepping the units and inner carrier stops outwardly for the knitting of the successively shortened courses of the heel gore, thereafter shifting said units rapidly inwardly between successive courses, and means for positioning the inner carrier stops inwardly thereafter for the knitting of the first long course of the next succeeding gore.

59. In a flat knitting machine, knitting instrumentalities including a series of spring beard needles movable as a unit, sinkers, a series of nibbed knockover bits, supporting means on which the knockover bits are capable of forward and back movement, resilient means urging the knockover bits forwardly, stop means for limiting the forward movement of the knockover bits in a position to cause the sinker wale kinks as they are drawn by the needles from the sinker noses to be engaged in and resiliently held by the knockover bits to the backs of the needles during the knockover, means for maintaining the knockover bits in a relatively retracted position during the remaining portion of the needle movements, yarn carriers and means associated therewith for causing selected end groups of needles of the series to knit heel fabric while no knitting takes place on intervening instep needles, a fabric takeup including means for tensioning the fabric to the backs of the needles, and means operative during the knitting of said heel courses to render said tensioning means inoperative.

60. In a flat knitting machine, knitting instrumentalities including a series of spring beard needles movable as a unit, sinkers, a series of nibbed knockover bits, supporting means on which the knockover bits are capable of forward and back movement, resilient means urging the knockover bits forwardly, stop means for limiting the forward movement of the knockover bits in a position to cause the sinker wale kinks as they are drawn by the needles from the sinker noses to be engaged in and resiliently held by the knockover bits to the backs of the needles during the knockover, means for maintaining the knockover bits in a relatively retracted position during the remaining portion of the needle movements, heel knitting yarn carriers, means cooperating with the needles to press the beards only of selected end groups of heel needles for the knitting of heel courses, while no knitting takes place on intervening instep needles, a fabric take-up, and means operative during the knitting of said heel courses to render said fabric take-up inoperative.

61. In a flat knitting machine, knitting instrumentalities including a series of needles movable as a unit, sinkers, and a series of nibbed knockover bits, yarn carriers and means cooperating therewith to cause selected end groups of needles of the series to knit heel fabrics while terminal loops are held on intervening needles with respect to which no knitting is taking place, means for maintaining said nibbed knockover bits resiliently in an advanced position during the knockover to position the sinker wale loops to the backs of the needles and thereafter to retract said knockover bits, a fabric take-up, means for operating said knitting instrumentalities in accordance with a heel knitting cycle for the production of heel fabric, and pattern means acting when rendered operative to condition said operating means for heel knitting and simultaneously to render said fabric take-up inoperative.

62. In a flat knitting machine, knitting instrumentalities including a series of spring beard needles movable as a unit, a narrowing machine having narrowing point units, a fabric take-up normally operative to take up the fabric as knitted, operating means including means for moving the needles and narrowing point units in accordance with a heel fabric knitting cycle of operation to cause the narrowing point units to close the beards of cooperating needles, and yarn carriers cooperating therewith for knitting heel fabric areas, a pattern mechanism including pattern operated connections for initiating said operation in accordance with a heel knitting cycle and for rendering said fabric take-up inoperative during the knitting of said heel areas.

63. The method of knitting a gored heel upon a flat knitting machine having needles, yarn measuring sinkers, dividers alternating therewith, and reciprocating yarn carriers, which comprises reciprocating heel yarn carriers to form heel courses, stopping each yarn carrier two needle indexes outwardly upon each successive inward traverse thereof, thereafter when the needles draw the new loops off the sinker noses, moving said inwardly fed carrier two needle indexes outwardly whereby the yarn leading from the reversing loop is disposed outwardly of the reversing needle to provide a single full loop of the yarn about the reversing needle and thereafter knitting the next course with an outward traverse of said carrier whereby a first full loop is formed on the next outwardly disposed needle from the reversing needle in the knitting of said second course.

64. The method of knitting a gored heel upon a flat knitting machine having needles, yarn measuring sinkers, dividers alternating therewith, and reciprocating yarn carriers, which comprises reciprocating heel yarn carriers to form heel courses, stopping each yarn carrier two needle indexes outwardly upon each successive inward traverse thereof, thereafter when the needles draw the new loops off the sinker noses, moving said inwardly fed carrier two needle indexes outwardly whereby the yarn leading from the reversing loop is disposed outwardly of the reversing needle to provide a single full loop of the yarn about the reversing needle and thereafter knitting the next course with an outward traverse of said carrier whereby a first full loop is formed on the next outwardly disposed needle from the reversing needle in the knitting of said second course, knitting a series of courses successively shortened in an identical manner to form the heel gore, and thereafter knitting a long course joining the terminal wale loops of the last short course and the terminal wale loops left in the knitting of said successively shorter courses.

65. The method of forming the heel portion of a stocking blank, which comprises knitting series of heel courses of progressively shorter length inwardly of the needle series on groups of active heel needles to form a plurality of inwardly tapered heel gores while holding the terminal wale loops of intervening instep and successively added heel fabric wales with respect to which no knitting is taking place, rendering the needles of an intermediate group including the instep needles inoperative with the terminal wale loops held thereon, and adding outwardly disposed heel needles to said intermediate group, laying a heel yarn inwardly in successive courses to more out-

wardly disposed needles to form the suture edge of the gore, and laying the heel yarn outwardly of the heel selvage edge in selected courses to more outwardly disposed needles to form a widened selvage edge of said gore whereby the heel is entirely shaped by the variable laying of yarn to the needle series.

66. The method of forming the heel portion of a stocking blank, which comprises knitting series of heel courses of progressively shorter length inwardly of the needle series on groups of active heel needles to form a plurality of inwardly tapered heel gores while holding the terminal wale loops of intervening instep and successively added heel fabric wales with respect to which no knitting is taking place, rendering the needles of an intermediate group including the instep needles inoperative with the terminal wale loops held thereon and adding outwardly disposed heel needles to said intermediate group, laying a heel yarn inwardly in successive courses to more outwardly disposed needles of one heel group, and in each next succeeding course laying a heel yarn inwardly to the correspondingly placed more outwardly disposed needle of the other heel needle group to form the suture edges of the gores, and laying a heel yarn outwardly of the heel selvage edge in selected courses to more outwardly disposed needles of one heel needle group and in each next succeeding course laying a heel yarn outwardly of the heel selvage edge to the corresponding more outwardly disposed needles of the other heel group to form widened selvage edges of said gores, whereby the heel is entirely shaped by the variable laying of yarn to the needle series.

67. The method of knitting a widened selvage fabric on a flat knitting machine, having knitting instrumentalities consisting of a series of spring-beard needles movable as a unit, means for pressing the needle beards, individually movable sinkers including sinkers shaped to permit movement of a yarn carrier across the sinkers in their advanced yarn kinking position, dividers alternating with the sinkers including dividers having an auxiliary yarn receiving slot below the normal yarn sinking level, knockover bits, and traversable yarn carriers, to produce a widened selvage fabric, which consists in the steps of raising the needles to the yarn sinking position, traversing a yarn carrier and advancing the sinkers in a knitting wave to kink yarn against the shanks of the needles, arresting the carrier over the normal selvage divider beyond the selvage needle employed in knitting the preceding course, continuing the advance of the sinkers including the selvage forming sinker to the yarn sinking position, moving the carrier two needle indexes outwardly to stand over the next outwardly disposed divider, advancing the dividers to re-position the kinked yarn against the shanks of all the needles, rocking the needles outwardly to move the feeding yarn extending from the carrier off of the nose and beneath the adjacent divider inwardly disposed from that over which the carrier stands, and traversing the carrier in a reverse direction from its widened position for the knitting of the next succeeding course so that the yarn extending from the reversing needle will enter the slot in the adjacent divider, and the first added needle having the yarn disposed beneath its outwardly disposed divider will cast off the bar of yarn comprising the widened selvage course.

68. The method of operating a knitting machine of the character described to produce a widened selvage edge, which comprises traversing a yarn carrier and advancing the yarn measuring sinkers in a knitting wave to kink yarn against the shanks of the needles, arresting the carrier over the normal selvage divider beyond the selvage needle employed in knitting the next preceding course, continuing the advance of the sinkers including the selvage forming sinker to the yarn sinking position, moving the carrier two needle indexes outwardly to stand over the next outwardly disposed divider, advancing the dividers to re-position the kinked yarn against the shanks of all the needles, and rocking the needles outwardly at the knockover to move the feeding yarn extending from the carrier to the last selvage loop, off the nose and beneath the divider disposed outwardly from the previously formed selvage loop, and traversing the carrier in a reverse direction from its widened position for the knitting of the next succeeding course.

69. The method of operating a knitting machine of the character described, which comprises operating the narrowing machine with the narrowing point units supported thereon and needles in accordance with a knitting cycle of operation to close the beards only of the needles acted upon by the narrowing points, and reciprocating heel knitting yarn carriers to feed yarn to selected numbers of said needles acted upon by the narrowing point units, imparting racking movements to the narrowing point units between courses, and correspondingly controlling the traverse of the heel carriers to feed yarn to selected variable numbers of said needles.

70. The method of operating a knitting machine of the character described, which comprises operating the narrowing machine with the narrowing point units supported thereon and needles in accordance with a knitting cycle of operation to close the beards only of the needles acted upon by the narrowing points, racking the narrowing point units outwardly one needle index subsequent to the knitting of each successive course, traversing heel knitting yarn carriers to feed yarn to the needles acted upon by the narrowing point units, moving the inner carrier stops outwardly two needle indexes upon the knitting of alternate courses to produce heel courses successively shortened at their inner ends, and at intervals moving the outward carrier stops outwardly to produce a widened selvage edge in certain of said courses.

71. The method of knitting a gored heel upon a flat knitting machine having needles movable as a unit, receprocating yarn carriers, inner and outer carrier stops, and means cooperating with the needles for causing selected groups of end needles to knit heel fabric areas while no knitting takes place upon intermediate instep and adjacent inactive heel needles, which comprises the steps of stepping the inner carrier stop outwardly in successive courses for laying yarn inwardly to more outward needles in successive courses, stepping the outer carrier stop outwardly in selected courses for knitting a gore having a widened selvage edge, and thereafter conditioning the inner carrier stop to cause the yarn carriers to knit a long course inwardly from the selvage edge to close the suture edge of the gore.

72. The method of knitting a gored heel upon a flat knitting machine having needles movable as a unit, reciprocating yarn carriers, inner and outer carrier stops, and means cooperating with the needles for causing selected groups of end needles to knit heel fabric areas while no knitting

takes place upon intermediate instep and adjacent inactive heel needles, which comprises stepping the inner carrier stops outwardly two needle indexes in each second course and stepping the outer carrier stops outwardly two needle indexes in selected courses to form a gore having a widened selvage edge, after a last short course conditioning the inner carrier stops to cause the carriers to knit a long course inwardly from the selvage edge terminating outwardly of the inner end of the first course of the first gore, knitting the second gore similarly with outward stepping of the inner carrier stops and at intervals with outward stepping of the outer carrier stops, conditioning the inner carrier stops for similarly knitting the third fabric gore with outward stepping of the inner carrier stops in alternate courses, and knitting a first course of foot fabric from selvage to selvage.

73. In a flat knitting machine, a machine frame, actuating mechanism including a cam shaft, knitting instrumentalities including a series of spring beard knitting needles, knockover bits, sinkers, and means for pressing the needle beards, a narrowing machine comprising a narrowing machine frame, press control means on the narrowing machine frame operable to control the press of selected needles of the series to cause selected groups of end needles to knit and the needles of the intervening groups of the series to hold their loops, means for actuating the narrowing machine and press control means with said knitting instrumentalities in a knitting cycle, indexing devices for indexing said press control means to effect variation in the number of needles inactive at each end of said intervening inactive group, yarn carriers, carrier stop control means including outer carrier stops, inner carrier stops, and pattern means to effect the actuation of the machine as described for the knitting of shaped heel areas.

74. In a flat knitting machine, a machine frame, actuating mechanism including a cam shaft, knitting instrumentalities including a series of spring beard knitting needles, knockover bits, sinkers, and means for pressing the needle beards, a narrowing machine comprising a narrowing machine frame, left and right side press control elements on the narrowing machine frame operable to control the press of selected needles of the series to cause selected groups of end needles to knit and the needles of the intervening group of the series to hold their loops, means for actuating the narrowing machine and press control elements with said knitting instrumentalities in a knitting cycle, indexing devices for indexing said press control elements to effect variation in the number of needles inactive at each end of said intervening inactive group, yarn carriers, carrier stop control means including outer carrier stops, inner carrier stops, and pattern means to effect the actuation of the machine as described for the knitting of shaped heel areas.

75. In a flat knitting machine, a machine frame, actuating mechanism including a cam shaft, knitting instrumentalities including a series of spring beard knitting needles, knockover bits, sinkers, and means for pressing the needle beards, a heel knitting apparatus comprising a frame, left and right side press control elements on the frame operable to control the press of selected needles of the series to cause selected groups of end needles to knit and the needles of the intervening group of the series to hold their loops, means for actuating the frame and press control elements with said knitting instrumentalities in a knitting cycle, indexing devices for indexing said left and right press control elements in opposite directions to effect variation in the number of needles inactive at each end of said intervening inactive group, yarn carriers, carrier stop control means including outer carrier stops, inner carrier stops, and pattern means to effect the actuation of the machine as described for the knitting of shaped heel areas.

76. In a flat knitting machine, a machine frame, actuating mechanism including a cam shaft, knitting instrumentalities including a series of spring beard knitting needles, knockover bits, sinkers, and means for pressing the needle beards, a heel knitting apparatus comprising a frame, press control means on the frame operable to control the press of selected needles of the series to cause selected groups of end needles to knit and the needles of the intervening group of the series to hold their loops, means for actuating the frame and press control means with said knitting instrumentalities in a knitting cycle, indexing devices for indexing said press control means to effect variation in the number of needles inactive at each end of said intervening inactive group, yarn carriers, carrier stop control means including outer carrier stops, inner carrier stops, and means for conditioning said indexing means and carrier stop means to cause the carriers to lay yarn inwardly to progressively outwardly disposed terminal needles, and the inactivated needles to be added to the intermediate inactive group for the knitting of inwardly tapered left and right heel gores.

77. In a flat knitting machine, a machine frame, actuating mechanism including a cam shaft, knitting instrumentalities including a series of spring beard knitting needles, knockover bits, sinkers, and means for pressing the needle beards, a heel knitting apparatus comprising a frame, press control means on the frame operable to control the press of selected needles of the series to cause selected groups of end needles to knit and the needles of the intervening group of the series to hold their loops, means for actuating the frame and press control means with said knitting instrumentalities in a knitting cycle, indexing devices for indexing said press control means to effect variation in the number of needles inactive at each end of said intervening inactive group, yarn carriers, carrier stop control means including outer carrier stops, inner carrier stops, and means for conditioning said indexing means and carrier stop means for the knitting of left and right heel gores while the intervening instep and adjacent inactive heel needles hold their loops wherein a heel carrier at that end of the needle series toward which the first heel course is knitted is moved inwardly over a plurality of inactivated needles of the instep series for joining the first course of heel knitting to the instep fabric.

78. In a flat knitting machine, a machine frame, actuating mechanism including a cam shaft, knitting instrumentalities including a series of spring beard knitting needles, knockover bits, sinkers, and means for pressing the needle beards, a heel knitting apparatus comprising a frame, press control means on the frame operable to control the press of selected needles of the series to cause selected groups of end needles to knit and the needles of the intervening group of the series to hold their loops, means for actuating the frame and press control means with said knitting instru-

mentalities in a knitting cycle, indexing devices for indexing said press control means to effect variation in the number of needles inactive at each end of said intervening inactive group, yarn carriers, carrier stop control means including outer carrier stops, inner carrier stops, and pattern means for actuating said indexing means to vary by one needle at each end of the instep group in each successive course the number of inactivated needles of the instep group, and to vary by two needles in alternate courses the inward traverse of the yarn carrier knitting each heel area.

79. In a flat knitting machine having a machine frame, actuating mechanism including a cam shaft, knitting instrumentalities including a series of spring beard knitting needles, knockover bits, sinkers, dividers alternating with the sinkers, a fixed press edge, yarn carriers, outer and inner carrier stops and actuating connections including needle in-and-out press and vertical motion cams adapted for pressing the needle beards against said press edge, the combination of a heel knitting apparatus which comprises an alternatively operable needle non-press in-and-out motion cam, a frame, left and right heel needle beard closing control elements carrried on the frame adapted to coact with variable groups of heel needles to cause said needles to cast off their loops, actuating cam means for the frame to move said control elements into and out of operative relation to the needles in accordance with a knitting cycle to cause the coacting needles to cast off their loops, screw and nut means for effecting indexing movements of said beard closing control elements in opposite directions to effect variation in the number of needles inactive between said heel needle control elements, yarn carriers, carrier stop control means including outer carrier stops, left and right inner carrier stops, indexing screw and nut means for effecting indexing movements of said inner carrier stops, and pattern means controlling said indexing means to effect successive indexed movements of said needle beard closing control elements and inner carrier stops therewith to knit left and right inwardly tapered gored heel segments while intervening terminal wale instep and adjacent inactive heel needle loops are held on their respective needles.

80. The method of forming the heel portion of a stocking blank, which comprises knitting heel courses of progressively varying length inwardly of the needle series on groups of active heel needles to form a left and right inwardly tapered heel gore while holding the terminal wale loops of intervening instep and heel fabric wales with respect to which no knitting is taking place on intervening inactive needles of the series, and in a similar manner knitting a second left and right inwardly tapered heel gore, while feeding yarn inwardly in the longest course of said latter left and right gore to a terminal wale loop supporting needle other than the needle supporting the innermost terminal wale loop of the longest course of the preceding gore.

81. The method of forming the heel portion of a stocking blank, which comprises knitting a series of heel courses of progressively varying length inwardly of the needle series on groups of active heel needles to form a plurality of inwardly tapered heel gores while holding the terminal wale loops of intervening instep and heel fabric wales with respect to which no knitting is taking place on intervening inactive needles, rendering the needles of the intermediate group including the instep needles inoperative with the terminal wale loops held thereon, feeding yarn inwardly of the needle series for the knitting of the longest course of each succeeding left and right gore to a terminal wale supporting needle outwardly disposed from the needle supporting the innermost terminal wale loop of the longest course of the preceding gore.

82. The method of producing a gored heel blank on a flat knitting machine having spring beard knitting needles, knockover bits, sinkers, a fixed press edge, yarn carriers, outer and inner carrier stops, and a heel knitting apparatus including a frame movable toward and away from the needles and left and right heel needle beard closing control elements carried on the frame, which comprises the steps of moving the needles in a knitting cycle away from the press edge, moving the frame and beard closing control elements in a knitting cycle coacting with groups of heel needles to cause said needles to cast off their loops, reciprocating heel yarn carriers to lay yarn to the heel needles, and indexing said beard closing control elements and carrier stops therewith to knit a plurality of successive inwardly tapered heel gores while knitting is suspended on the instep and adjoining inactive heel needles.

83. The method of producing a gored heel blank on a flat knitting machine having spring beard knitting needles, knockover bits, sinkers, a fixed press edge, yarn carriers, outer and inner carrier stops, and a heel knitting apparatus including a frame movable toward and away from the needles and left and right heel needle beard closing control elements carried on the frame, which comprises the steps of moving the needles in a knitting cycle away from the press edge, moving the frame and beard closing control elements in a knitting cycle coacting with groups of heel needles to cause said needles to cast off their loops, reciprocating heel yarn carriers to lay yarn to the heel needles, indexing inner carriers stops and said beard closing control elements therewith to knit inwardly tapered gores having courses of successively varying length, and imparting a return rapid indexing movement over a substantial number of needles to the beard closing control elements and re-positioning inner carrier stops therewith upon the completion of one gore and prior to the knitting of a next succeeding gore.

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