Nov. 18, 1969 E. P. HOMAN 3,478,544

METHOD OF KNITTING SHEER SEAMLESS SUPPORT STOCKINGS

Filed Sept. 25, 1967 4 Sheets-Sheet 1

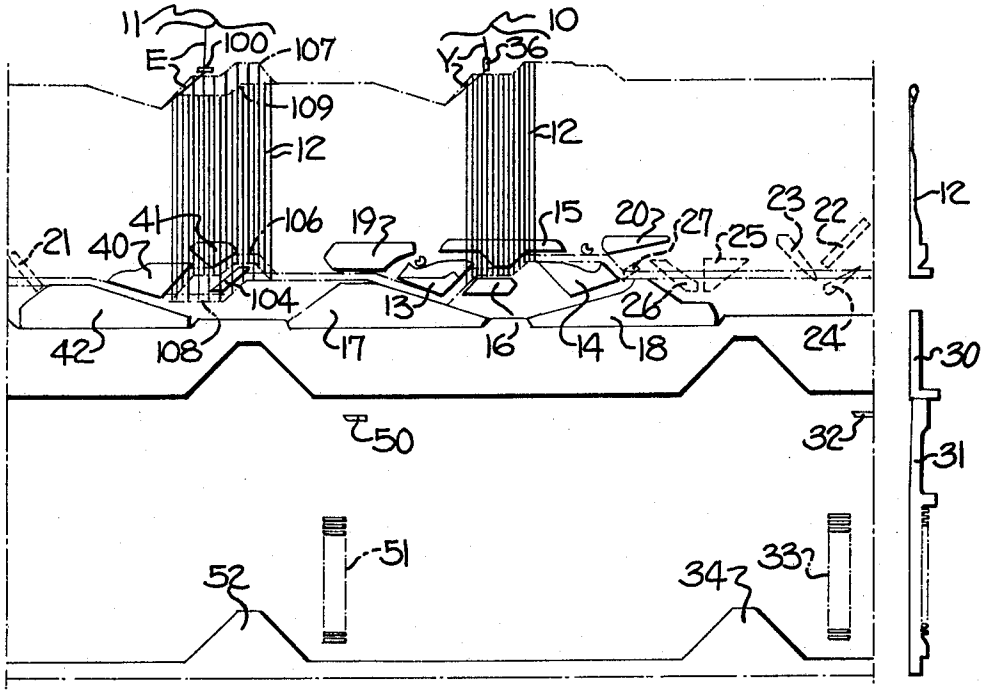


Fig-1

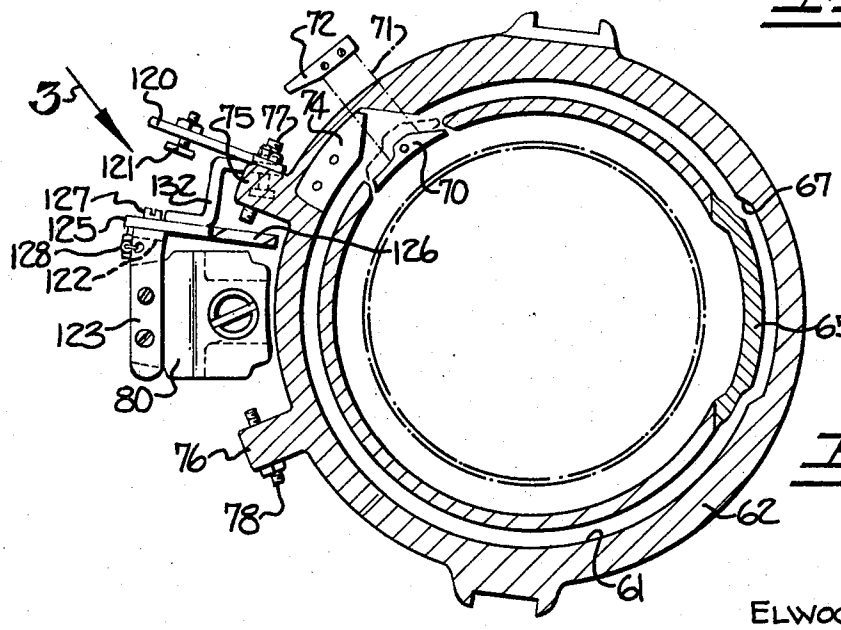


Fig-2

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Filed Sept. 25, 1967 4 Sheets-Sheet 2

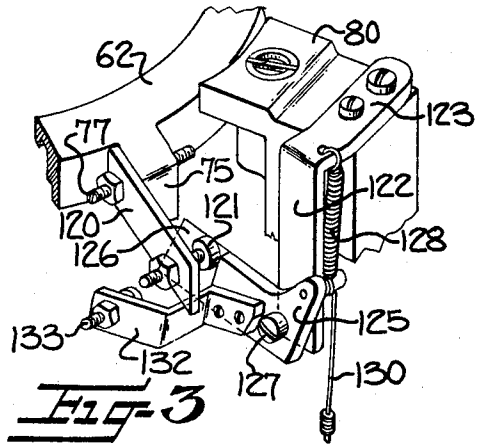


Fig-3

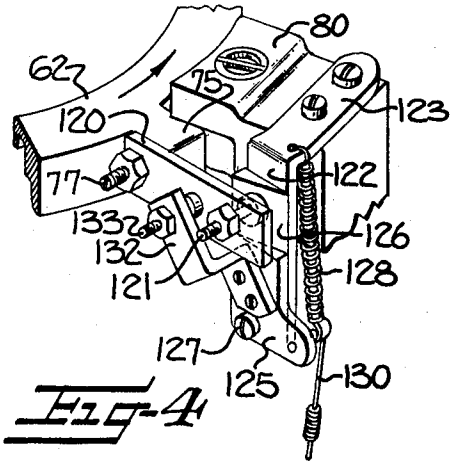


Fig-4

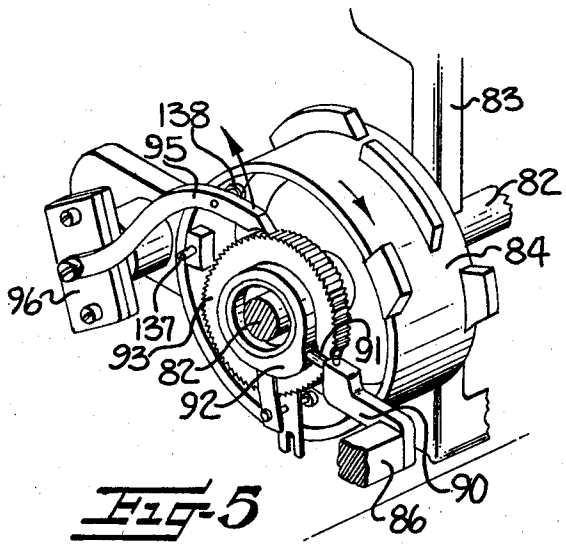


Fig-5

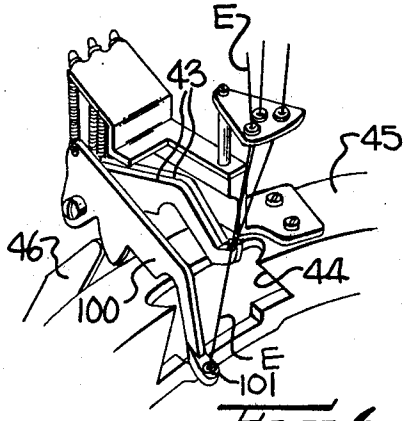


Fig-6

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METHOD OF KNITTING SHEER SEAMLESS SUPPORT STOCKINGS

Filed Sept. 25, 1967 4 Sheets-Sheet 3

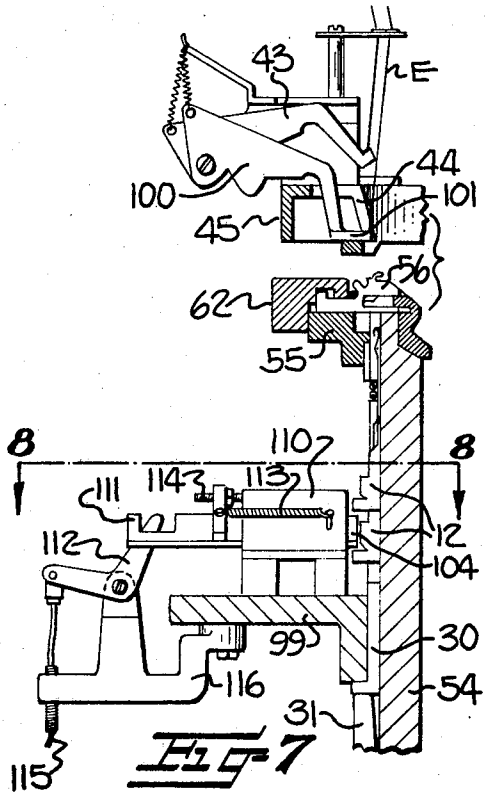


Fig-7

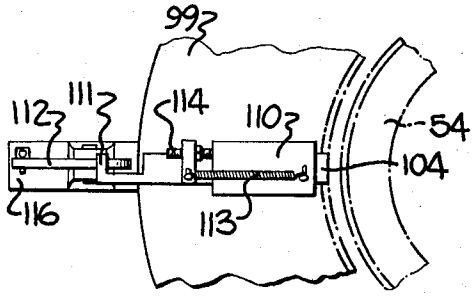


Fig-8

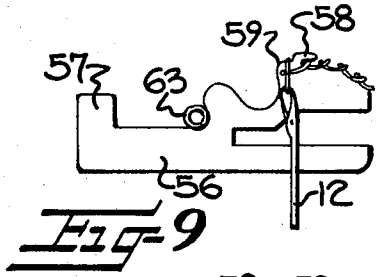


Fig-9

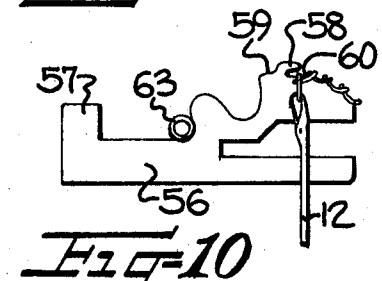


Fig-10

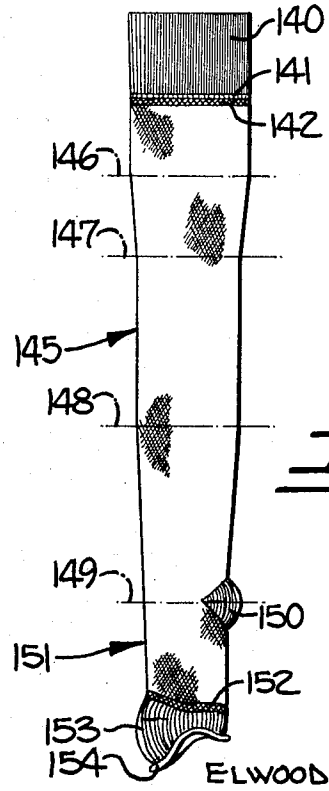


Fig-11

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METHOD OF KNITTING SHEER SEAMLESS SUPPORT STOCKINGS

Filed Sept. 25, 1967 4 Sheets-Sheet 4

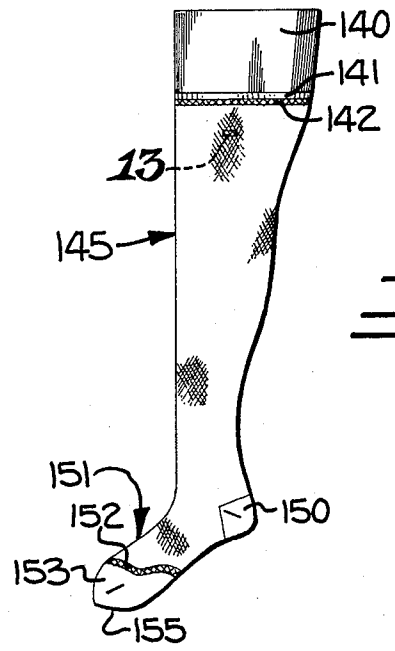


Fig-12

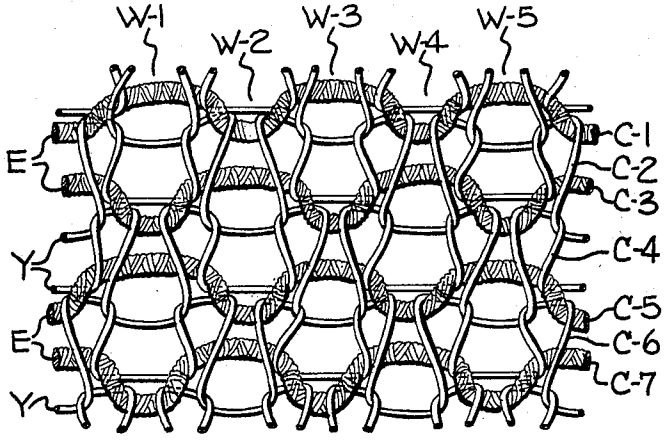


Fig-13

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United States Patent Office 3,478,544 Patented Nov. 18, 1969



3,478,544

# METHOD OF KNITTING SHEER SEAMLESS SUPPORT STOCKINGS

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Int. Cl. D04b 15/06, 9/46
U.S. Cl. 66—108 4 Claims

## ABSTRACT OF THE DISCLOSURE

This method includes feeding a nylon body yarn to every needle and forming stitch loops thereon at one knitting station of a multi-feed circular knitting machine while feeding a covered spandex yarn to alternate needles and forming stitch loops thereon at the next successive knitting station. The covered spandex yarn is fed under a substantial amount of tension, in the range of about 10 grams, while the stitch forming instrumentalities are controlled to incorporate a greater length of nylon body yarn and a lesser length of covered spandex yarn to enhance the sheer appearance of the stocking.

This invention is directed generally to the production of ladies' seamless sheer support stockings and more particularly to an improved method of knitting which enhances the sheer appearance of the stockings and provides the proper support on the leg of the wearer.

It is known to knit a support stocking on a multi-feed circular hosiery knitting machine by feeding an inelastic body yarn to every needle and forming stitch loops thereon at one knitting station while feeding a covered elastic yarn to alternate needles and forming stitch loops thereon at the next knitting station. This method of knitting a support stocking is disclosed in the York et al. Patent No. 3,250,092, issued May 10, 1966. Support stockings knit in accordance with the method of this patent have an open mesh and sheer appearance with a gradually reducing compressive effect from the ankle upwardly to the top of the stocking and have received widespread acceptance by both manufacturers and consumers.

As pointed out in this York et al. patent, it is important to feed the inelastic body yarn under substantially no tension and the elastic yarn under a slight tension while forming normal size stitches of the body yarn and abnormally large stitches of the elastic yarn. In this patent, it is suggested that the tension on the elastic yarn be maintained from about 6 to 8 grams and that the large stitches of the elastic yarn be formed by drawing the needles down to an abnormally low stitch position by means of the stitch cams. This method requires one adjustment of the stitch cams at the elastic yarn knitting station during the knitting of the leg portion of the stocking and another adjustment of the stitch cams to knit plain fabric of inelastic yarn, such as when the welt is to be knit in a two-feed manner by feeding body yarn to both knitting stations. Unless this adjustment of the stitch cams is very accurate, stitch loops of different sizes will be formed at each knitting station and cause coursewise streaks in the welt. The formation of large stitches of the elastic yarn also increases the length of elastic yarn that is drawn into the stocking.

This York et al. patent also suggests that the shaping of the leg portion of the stocking be accomplished during the knitting operation by the conventional fashioning mechanism which gradually reduces the stitch size as the leg is being knit. By the conventional process, the leg portion of the stocking gradually is reduced and uniformly tapers from the ankle to a position below the



welt. While this method of fashioning is widely used in the knitting of both regular and support stockings, I have now discovered a more efficient method of shaping for support hosiery so as to provide the desired amount of support on all portions of the leg of the wearer.

With the foregoing in mind, it is an object of the present invention to provide an improved method of forming support stockings which enhances the sheer appearance and overcomes the above-mentioned and other difficulties encountered in the knitting of ladies' sheer seamless support stockings by the known methods.

Generally, the enhanced sheer appearance is obtained by incorporating a greater length of the inelastic body yarn into the fabric while reducing the length of elastic yarn therein. In accordance with the present method, this is achieved by drawing the inelastic yarn down in front of the nibs of the sinkers and moving the sinkers inwardly at an earlier than normal position at the knitting station to form relatively large inelastic yarn stitches in every wale, and knitting the elastic yarn on alternate needles while drawing the elastic yarn down behind the nibs of the sinkers and maintaining a relatively high tension on the elastic yarn.

The relative difference in size of the stitch loops formed of the elastic and inelastic yarns and the high tension placed on the elastic yarn cooperate in such a manner as to increase the length of the inelastic yarn incorporated in the stocking, relative to the length of the elastic yarn incorporated therein. This method of knitting also causes the elastic yarn to be incorporated in the finished stocking in a more sinuous path than in stockings knit in accordance with the usual method.

In accordance with a further feature of the method of the present invention, the support stocking is fashioned during knitting by varying the size of the stitch loops in such a manner as to obtain the desired amount of compressive force in particular areas of the stocking. To this end, certain portions of the leg of the stocking are fashioned by gradually decreasing the stitch size being knit at both knitting stations and the stitch size is maintained constant at both knitting stations during the knitting of other portions of the leg of the stocking. For example, it is preferred that the upper portion of the leg, just below the turned welt, and a medial portion of the leg be knit with stitch loops of a uniform size and that the lower portion of the leg and the intermediate section of the leg between the upper and medial portions be knit while the stitch size is gradually reduced at both knitting stations.

Some of the objects of the invention having been stated, other objects will appear as the description proceeds when taken in connection with the accompanying drawings, in which—

FIGURE 1 is a developed view of the needle operating cams and jack selecting and operating cams of a preferred type of machine on which the present method is carried out;

FIGURE 2 is a sectional plan view of the sinker cap of the machine, and illustrating the mechanism for, at times, retarding the rotational movement of the sinker cap to cause the sinkers to be advanced at an earlier than normal position at the main or inelastic knitting station;

FIGURE 3 is an enlarged isometric view of the sinker cap rotation retarding mechanism, looking inwardly in the direction of the arrow 3 in FIGURE 2;

FIGURE 4 is a view similar to FIGURE 3, but showing the sinker cap retarding arm in operative position with the sinker cap rotated to its limit in a counterclockwise direction;

FIGURE 5 is a fragmentary isometric view of the size control drum of the knitting machine and illustrating the

manner in which the fashioning cam is operated to vary the fashioning of the stocking during knitting;

FIGURE 6 is a fragmentary isometric view of a portion of the latch ring, illustrating the manner in which the yarn feed fingers are mounted and supported at the auxiliary or elastic yarn knitting station;

FIGURE 7 is a vertical sectional view through the needle cylinder at the auxiliary knitting station and illustrating the manner in which the needle lowering cam is supported for providing substantial separation between those needles which pick up and knit the elastic yarn and those needles across which the elastic yarn is floated;

FIGURE 8 is a fragmentary sectional plan view of the needle lowering cam, taken substantially along the line 8—8 in FIGURE 7;

FIGURE 9 is an elevational view of a sinker and the upper portion of a needle, illustrating their relative positions at the auxiliary knitting station as the needles are lowered to draw the elastic yarn over the stitch forming ledges behind the nibs of the sinkers;

FIGURE 10 is a view similar to FIGURE 9, but illustrating the relative positions of a needle and sinker at the main knitting station where the inelastic body yarn is drawn down over the stitch forming ledges in front of the nibs of the sinkers;

FIGURE 11 is a side elevational view of a support stocking blank, as it comes from the knitting machine, and illustrates the manner in which the stitch loops are graduated in two separate portions of the leg of the stocking blank;

FIGURE 12 is a side elevational view of the finished support stocking; and

FIGURE 13 is a greatly enlarged view of a small portion of the fabric of the stocking, being in the area of the dotted rectangle **13**, in FIGURE 12, and illustrating the manner in which the elastic yarn is incorporated in a sinuous path in the stitches of inelastic body yarn to provide the sheer, open-mesh appearance.

In the drawings, portions of a "Reading" Mark III, two-feed, 403 needle, circular knitting machine are shown. Only those portions of the machine are shown which are considered necessary to an understanding of the present invention. Further details of this type of machine are shown in the "Reading Mark III" parts catalogue published by Textile Machine Works and copyrighted in 1962. Reference may also be made to U.S. Patent Nos. 3,252,307 and 3,307,377, which illustrate portions of this type machine.

While the method of the present invention is described as being carried out on this particular type of circular hosiery knitting machine, it is to be understood that the method may also be practiced on other types of circular hosiery knitting machines by making very slight modifications, similar to those modifications herein described in connection with the "Reading" machine. The conventional portions of the knitting machine are first described; then the modifications are described which have been necessary in order to knit a support stocking in accordance with the method of the present invention; and finally, the method of the present invention is described as practiced on the modified machine.

The machine is of the multi-feed type and in the present instance, is provided with two knitting stations, generally designated as the respective main and auxiliary knitting stations **10**, **11** in FIGURE 1. The cams which operate on the butts of the needles **12** at the main station **10** (FIGURE 1) include a forward stitch cam **13**, a reverse stitch cam **14**, a top center cam **15**, and a lower center or needle leveling cam **16**. Needle leveling end cams **17**, **18** are provided adjacent opposite sides of the respective forward and reverse stitch cams **13**, **14**, and guard cams **19**, **20** are positioned above the respective end cams **17**, **18**.

The usual needle raising and lowering cams are supported for radial movement into and out of operative



position. These cams are shown in the dotted line inoperative position and may be moved inwardly to engage the butts of the needles **12** as they approach the main knitting station **10**. These needle cams include a needle raising cam **21**, a needle lowering cam **22**, switch cams **23**, **24**, transfer cams **25**, **26**, and a divider cam **27**.

An auxiliary jack **30** and a pattern jack **31** are provided beneath each latch needle **12**, and as the pattern jacks **31** approach the main knitting station **10**, the upper ends are engaged by a presser cam **32** to rock the lower pattern butt portion of the pattern jack **31** outwardly of the needle cylinder so that the butts thereon may be engaged by a bank of selector levers **33**. If a butt on the pattern jack **31** is engaged by a selector lever **33**, the lower end of the pattern jack is rocked back inwardly. The selector levers **33** are operated from the usual pattern drum, not shown, and the pattern drum and butts on the pattern jack **31** are set up to provide the desired pattern in the stocking.

A jack raising cam **34** is provided to engage the stepped lower butt on the pattern jack **31** if it is not rocked back into the needle cylinder by the selector levers **33**. Thus, selected ones of the pattern jacks **31** and corresponding auxiliary jacks **30** and needles **12** will be raised by the jack raising cam **34** while the remaining pattern jacks will not be raised. The main knitting station **10** is also provided with a plurality of yarn feed fingers, only one of which is shown at **36** in FIGURE 1. These yarn feed fingers **36** are supported for movement into and out of yarn feeding position in a conventional throat opening, not shown.

The auxiliary knitting station **11** includes needle butt engaging cams comprising a stitch cam **40**, an upper center cam **41**, and a needle leveling end cam **42**. The auxiliary knitting station **11** is usually provided with a lower center or leveling cam which is supported below the center cam **41**. In accordance with the present invention, the center cam has been removed and replaced by a radially movable needle lowering cam, to be later described.

A plurality of conventional body yarn feed fingers **43** (FIGURES 6 and 7) are pivotally supported for movement into and out of yarn feeding position in a throat opening **44**, formed in the latch ring **45**. The yarn feed fingers **43** are normally urged downwardly to the operative or feeding position by suitable springs and may be raised to the inoperative position by conventional thrust rods **46** (FIGURE 6). A special yarn feed finger (to be later described) is also provided at the auxiliary knitting station for use in feeding a covered spandex yarn.

A jack presser cam **50** is provided in advance of the auxiliary knitting station **11** to rock the lower ends of the jacks **31** outwardly so that they may be selectively engaged and pressed inwardly by a bank of selector levers **51**. Those jacks **31** which are engaged by the selector levers **51** are not raised by a jack raise cam **52** (FIGURE 1) while the remaining jacks **31** are raised thereby. The selection of the needles to be raised at the auxiliary knitting station **11** will be presently described.

As shown in FIGURE 7, the latch needles **12** and corresponding jacks **30**, **31** are supported for vertical sliding movement in slots in the needle cylinder **54** and a radially slotted sinker bed **55** is supported on the upper end of the needle cylinder **54**. Sinkers **56** (FIGURES 7, 9 and 10) are supported for radial movement in the radial slots of the sinker bed **55** and for operation between the needles **12**. The sinkers **56** are each provided with an upstanding operating butt **57**, a nib **58**, a stitch drawing ledge **59** behind or outside of the nib **58**, and a stitch drawing ledge **60** in front of or inside of the nib **58**. It will be noted in FIGURES 9 and 10 that the stitch drawing ledge **59** is slightly higher than the stitch drawing ledge **60**, and the needles **12** may draw the yarn down over either of these ledges, for purposes to be presently described in connection with the method of the present invention.

The upstanding butts **57** of the sinkers **56** ride in a

cam track **61** in a sinker cap **62** (FIGURE 2) and the sinkers **56** are normally urged to their innermost position by a spring band **63** (FIGURES 9 and 10). As the sinkers **56** approach the main knitting station, their butts engage a sinker withdrawing cam **65** (FIGURE 2) and the sinkers **56** are withdrawn or retracted to substantially the position shown in FIGURE 10 where the needles will draw the yarn downwardly over the stitch drawing ledges **60**, at the main knitting station. During conventional knitting, the sinkers **56** are moved inwardly as their butts engage an inclined cam surface **67** on the sinker cap **62** (FIGURE 2) to press the cast-off stitches inwardly after the needles have been drawn down to stitch drawing level.

A sinker withdrawing cam **70** is supported at the auxiliary knitting station for radial movement between the solid-line and dotted-line positions shown in FIGURE 2. The sinker cam **70** is fixed on the inner end of a stem portion **71** and an operating abutment **72** is provided on the outer end thereof. The abutment **72** is engaged by the usual operating linkage, not shown, to selectively position the cam **70** in the desired position. When the sinker cam **70** is in the innermost solid-line position shown in FIGURE 2, the sinkers **56** are not retracted at the auxiliary knitting station **11**, but remain in the innermost position so that the needles **12** draw the yarn down over the outer stitch drawing ledges **59**, in the manner illustrated in FIGURE 9 and for purposes to be presently described. At times, the sinker cam **70** will be moved outwardly to the dotted-line position so that the sinkers **56** are withdrawn at the auxiliary knitting station **11** and the needles draw the yarn down over the stitch drawing ledges **60**, in front of the nibs **58**. When the sinkers **56** are withdrawn by the cam **70**, they are moved back inwardly by an inclined cam **74** on the sinker cap **62** (FIGURE 2).

As shown in FIGURE 2, the sinker cap **62** is provided with spaced apart outwardly extending lugs **75**, **76** which are provided with respective threaded stop abutment screws **77**, **78**. The inner ends of the abutment screws **77**, **78** normally engage opposite sides of a latch ring post **80** to thereby limit relative rotational movement of the sinker cap **62**, during reciprocation of the needle cylinder **54**. The sinker cap **62** is shown in FIGURE 2 in the neutral position; i.e., with the ends of the abutment screws **77**, **78** substantially equally spaced from opposite sides of the post **80**.

As the normal forward rotation is imparted to the needle cylinder **54**, in a counterclockwise direction in FIGURE 2, the free end of the abutment screw **77** will move against the post **80** and limit counterclockwise movement of the sinker cap **62**. When movement is imparted to the needle cylinder in the opposite direction, as during reciprocation, the free end of the abutment screw **78** will engage the post **80** and limit clockwise movement of the sinker cap **62**. This limited movement of the sinker cap **62** is conventional and, in accordance with the present invention, means (to be later described) is provided for limiting the amount of counterclockwise movement of the sinker cap **62**.

A front pattern shaft **82** (FIGURE 5) is rotatably supported in the lower front portion of the machine frame **83** and a left-hand pattern drum **84** is fixed thereon. Other conventional pattern drums, not shown, are supported on the shaft **82**, and the shaft **82** and the drums fixed thereto are rotated in a predetermined sequence, according to the pattern provided on the main pattern chain, not shown. The length of stitch knit in various portions of the stocking is normally controlled by raising and lowering the needle cylinder **54**, relative to the stitch cams, to correspondingly lengthen and shorten the stitch being formed.

The vertical position of the needle cylinder **54** is normally controlled by means of a quality lever, a portion of which is shown at **86** in FIGURE 5. The lever **86** is normally provided with a plurality of cam pins, not shown, which engage different cam races of a size control drum, not shown. One end of a graduating arm **90** (FIGURE 5) is attached to the quality lever **86** and has a cam pin **91** in its free end which is adapted to engage and ride on a graduating cam **92**, fixed on a graduating rack wheel **93**, supported for rotation on the pattern shaft **82**.

The forward end of a racking lever **95** (FIGURE 5) is in engagement with the teeth of the rack wheel **93** and the rear end is pivotally connected to an oscillating plate **96** which is, in turn, fixed on the end of the quadrant shaft of the machine so that continuous oscillation is imparted to the racking lever **95**. During normal operation of the knitting machine, the size of the stitches being formed is at times controlled by the graduating cam **92** and the graduating arm **90**. The rack wheel **93** is normally moved in a continuous step-by-step manner so that the size of the stitch loop being knit throughout the lower part of the leg of the stocking is gradually reduced in a fairly constant manner, depending upon the particular configuration of the graduating cam **92**.

This cam **92** is usually designed so that the stocking blank gradually tapers from the calf to the ankle, where the stitches are made as small as possible. In accordance with the present invention, means is provided for interrupting the movement of the graduating cam **92** at predetermined intervals so that the stitch loop size will remain the same. This mechanism will be presently described in detail.

As shown in FIGURES 7 and 8, a circular bed plate **99** is supported in a conventional manner and surrounds the needle cylinder **54** to support the conventional needle butt engaging cams. The bed plate **99** also supports a special needle lowering cam at the auxiliary knitting station **11**, to be presently described in detail. The parts heretofore described are conventional, except where noted, and the parts will now be described which have been added in order to carry out the present method.

In accordance with the present invention, an inelastic yarn, indicated at Y in FIGURE 1, is fed to all the needles at the main feeding station **10** and through the yarn feed finger **36** and an elastic yarn, indicated at E in FIGURE 1 is fed to alternate needles at the auxiliary knitting station **11** and through a special feed finger **100**. The feed finger **100** (FIGURE 6) is provided with a special ceramic guide eye **101** and extends inwardly slightly inside of the inner surface of the latch ring **45** at the throat opening **44** so that the elastic yarn E does not drag over and engage the metal surface at the corners of the throat opening **44**.

The elastic yarn E preferably has a spandex core with a nylon covering, and if it is permitted to drag over the corners of the throat opening **44**, the covering yarn may be skinned back or disrupted, and variable tension will be imparted to the yarn as it is fed through the needles, thereby resulting in a non-uniform product. Thus, by providing the horizontally disposed guide eye **101** (FIGURE 6) and positioning the finger **100** so that it is inside of the latch ring **45**, the elastic yarn E does not run against any portion of the machine and the yarn is fed to the needles under uniform tension.

A needle lowering cam **104** is provided at the auxiliary knitting station **11** (FIGURE 1) to provide a wide separation between those needles which are selected to pick up and knit the elastic yarn E and those needles which are not raised to pick up the elastic yarn E. This cam **104** insures a positive floating of the elastic yarn inside of those needles which are not raised at the auxiliary knitting station **11**.

In accordance with the present invention, every other needle is raised by the jack raising cam **52** and the pattern jacks **31** so that their butts are raised to pass along a dotted line pathway **106** and their hooks move along a dotted line pathway **107** to pick up the elastic yarn E therein. Those needles which are not raised move along

a level path until their butts engage the needle lowering cam **104**. The butts of the needles are then lowered by the cam **104** to move along a dotted line path **108** while their hooks are lowered to move along a dotted line path **109** and below the yarn feed finger **100** a sufficient distance that they do not pick up the elastic yarn E and so that the elastic yarn will be floated inside these needles, in a positive manner. As shown in FIGURES 7 and 8, the needle lowering cam **104** is supported for radial movement into and out of operative position in a cam block **110**, which is in turn fixed on the bed plate **99**. The outer stem portion of the cam **104** is provided with an abutment **111** which is engaged by the upper end of a bell crank lever **112**.

A tension spring **113** normally urges the cam **104** to an innermost position, which is adjustable by means of an adjustment stop screw **114**. The cam **104** may be moved to an inoperative position by counterclockwise movement of the bell crank **112**, by means of a Bowden wire cable **115**, one end of which is connected to the bell crank **112** and the other end of which is operated by a suitable lever on a conventional pattern drum, not shown. The bell crank **112** is suitably supported for pivotal movement on a bracket **116** (FIGURE 7) which is in turn fixed on the bed plate **99**.

In accordance with the present invention, the shifting or rotational movement of the sinker cap **62** in a counterclockwise direction (FIGURE 2) is limited by means of a bunter plate **120**, the inner end of which is fixed on the adjustment stop screw **77** and the outer end of which is provided with an adjustably supported bunter or stop screw **121**. The free head end of the bunter **121** is normally adapted to engage the vertical leg **122** of a stop bracket which has a horizontal leg **123** fixed to the upper end of the post **80** (FIGURES 3 and 4). During normal operation with the needle cylinder rotating continuously in a counterclockwise direction, the sinker cap **62** will be rotated to a position where the bunter stop **121** remains in engagement with the vertical leg **122** of the stop bracket. With the sinker cap **62** in this position, the sinkers will be moved inwardly at the main knitting station **10** by the inclined cam surface **67** (FIGURE 2) and in the conventional manner; i.e., after the needles have been lowered to the full stitch drawing position.

As is well known, by advancing the sinker cap so that the sinkers are advanced or moved inwardly at an earlier than normal position, the yarn is pushed inwardly between the needles by the nibs **58** of the sinkers and additional yarn is drawn into each stitch loop so that the stitch loops are somewhat enlarged. In the present instance, the counterclockwise rotational movement of the sinker cap **62** is retarded or limited by a bell crank control lever **125** which has a cammed upper end portion **126** and is pivotally supported as at **127** on the lower end of the vertical leg **122** of the stop bracket (FIGURE 4). A tension spring **128** is connected at one end to the bell crank control lever **125** and its other end is connected to the horizontal arm **123** of the support bracket to thus normally urge the control lever **125** to the inoperative position shown in FIGURE 3 so that the stop bunter **121** will directly engage the surface of the vertical leg **122**.

One end of a Bowden wire cable **130** is connected to the bell crank **125** and the other end is suitably connected to a control lever which is operated by the conventional cams on the usual pattern drum, not shown. The cable **130** will, at times, move the bell crank **125** from the inoperative position shown in FIGURE 3 to the operative position shown in FIGURE 4 so that the bunter stop **121** will engage the upper cam surface **126** of the bell crank **125** and thereby prevent rotation of the sinker cap **62** to the full counterclockwise position.

In order to positively hold the sinker cap **62** in the correct adjusted position, a Z-shaped support arm **132** (FIGURES 3 and 4) is connected at one end to one side of the bell crank **125** and its other end is provided with an adjustable stop screw **133**. Thus, as the bell crank **125** is moved from the inoperative position shown in FIGURE 3 to the operative position shown in FIGURE 4, the adjustable bunter **133** moves against the outer surface of the bunter plate **120** and the sinker cap **62** is held in a secure position by the cam surface **126** engaging the bunter stop **121**.

In accordance with the present invention, means is provided for interrupting the movement of the graduating cam **92** (FIGURE 5) so as to maintain the stitch loop size uniform during a predetermined portion of the knitting of the leg portion of the stocking. In the present instance, this interrupting means includes an operating pin **137** fixed to the inner surface of the pattern drum **84** (FIGURE 5) and a roller **138**, secured to a medial portion of the racking lever **95**. The roller **138** is positioned to be engaged by the pin **137** to lift the racking lever **95** out of engagement with the rack wheel **83** and stop step-by-step rotation of the rack wheel **93** and the graduating cam **92**, for purposes to be later described.

## METHOD OF OPERATION

During the knitting of a stocking blank, such as is shown in FIGURE 11, the knitting usually proceeds from the top to the bottom and will be described in this manner in connection with the present invention. It is preferred that the upper end of the stocking blank (FIGURE 11) be formed with a conventional turned welt **140** which is preferably knit of a textured nylon multifilament yarn of about 40 denier to provide some stretchability to the fabric. The turned welt is preferably knit in a two-feed manner, after the make-up courses are formed in a conventional manner and the stitch loops are held on the transfer points of the dial, not shown, until they are transferred back to the cylinder needles to form the turned welt portion. During this conventional knitting on all of the needles at each knitting station **10**, **11**, in the formation of the welt **140**, it is preferred that the sinker cam **70** (FIGURE 2) be moved to the dotted line position so that the yarn is knit in front of the nibs **58** of the sinkers **56** at both knitting stations. The bunter screw **121** is positioned against the vertical leg **122** of the support bracket so that the sinker cap **62** is in the normal position and the sinkers **56** move inwardly at both the main knitting station **10** and the auxiliary knitting station **11** to form normal size stitches over the ledges **60**.

During the knitting of the welt portion **140**, the stitch size is regulated in a conventional manner and the stitches are of uniform size throughout the welt **140**, the short shadow or after welt **141**, and the run-stop guard **142**. The stitch cams **13** and **40** (FIGURE 1) are adjusted to form the same size stitch at each knitting station **10**, **11** during the plain knitting of these parts of the stocking. It should be noted that in knitting a stocking according to the method of the present invention, it is not necessary to change the relative positions of the stitch cams **13**, **40** to obtain the desired variation in stitch length, since the stitch length is varied by other means.

As the knitting of the leg portion, broadly indicated at **145** in FIGURE 11, begins, the covered spandex yarn E is introduced to the needles by lowering the special yarn feed finger **100** into the operative position shown in FIGURE 7 just prior to raising the yarn feed finger **43** which has been feeding the regular nylon multifilament yarn. With the introduction of the covered spandex yarn E at the auxiliary knitting station **11**, the nylon body yarn Y is introduced at the main knitting station **10**. This nylon body yarn Y is preferably 20 denier monofilament nylon 66.

The sinker cam **70** is moved to the solid line position shown in FIGURE 2 so that the sinkers **56** do not retract or move outwardly at the auxiliary knitting station **11**. The bell crank **125** is moved to the operative position shown in FIGURE 4 to thereby shift the sinker cap in a

clockwise direction a distance of about one-sixteenth of an inch so that the sinkers **56** are moved inwardly at the main knitting station **10** earlier than normal and thereby cause longer stitches to the drawn at the main knitting station **10** than the stitches drawn at the auxiliary knitting station **11**.

The needle lowering cam **104** is also moved inwardly to the operative position shown in FIGURE 1 and the selector levers **51** operate to cause alternate needles **12** to be raised to take and knit the covered spandex yarn E at the auxiliary knitting station **11** during alternate rotations of the needle cylinder and, during intervening rotations of the needle cylinder, intervening needles **12** are raised to take and knit the covered spandex yarn E. The needles which do not raise and take the elastic yarn remain in a lower position and are dranw by the cam **104** so that the elastic yarn E is floated inside these needles, in a positive manner. The leg portion **145** is knit with the machine set in this manner so that a course of body yarn Y is knit on every needle and a course of covered spandex yarn E is knit on every other needle with each rotation of the needle cylinder.

As shown in FIGURE 13, the body yarn Y is knit in every wale W–**1** through W–**5** of courses C–**2**, C–**4** and C–**6**. The covered spandex yarn E is knit in wales W–**2**, W–**4** of courses C–**1** and C–**5** and floated across wales W–**1**, W–**3** and W–**5**. The yarn E is knit in wales W–**1**, W–**3** and W–**5** of courses C–**3** and C–**7** and floated across wales W–**2** and W–**4**. Thus, in alternate elastic courses, the yarn E is knit on alternate needles and during intervening elastic courses, the yarn E is knit on intervening needles so that the wales in which the elastic yarn is knit are staggered throughout the knitting of at least the leg portion **145**.

A schematic illustration of this method of knitting of the body yarn in every wale and the staggered knitting and floating of the elastic yarn is illustrated in FIGURE 17 of the aforementioned York et al. Patent No. 3,250,092. This figure illustrates the manner in which the fabric would appear if it were knit entirely of non-elastic yarn; however, the elastic yarn does not retain the definite stitch loop configuration but tends to straighten out when the fabric is relaxed so that the fabric has substantially the appearance shown in FIGURE 13.

In the stocking of the present invention, the yarn E follows a more sinuous path in the fabric (FIGURE 13) than the elastic yarn in the fabric illustrated in FIGURE 18 of the York et al. patent. This more sinuous path of the elastic yarn in the fabric of the present invention is partly caused by the greater amount of tension applied to the elastic yarn E, about 10 grams, and due to the fact that a greater length of body yarn Y is incorporated in the fabric by the increased length of stitch caused by the early inward movement of the sinkers at the main knitting station. These factors cause alternate stitch loops of the body yarn to take on different shapes. As shown in FIGURE 13, narrow body yarn stitches alternate with short wide body yarn stitches in both coursewise and walewise directions to provide a more definite open-mesh appearance.

During the knitting of the upper portion or first segment of the leg portion **145**, down to the dash-dot line **146** (FIGURE 11), the stitch loops are maintained the same size from course to course so that the stocking blank is of substantially the same diameter down to the line **146**. During the knitting of this first portion, the stitch size is regulated from the regular size drum of the machine, not shown, and in the conventional manner.

As the next section of the leg is knit, between the dash-dot line **146** and the dash-dot line **147** (FIGURE 11), the size of the stitch loops is gradually decreased at both knitting stations by means of the graduating cam **92** (FIGURE 5) and during this time the position of the needle cylinder is controlled by the graduating arm **90**. Because of the shape of the graduating cam **92**, and the step-by-step movement imparted thereto by the racking lever **95**, the stitch loop size is gradually decreased to thereby reduce the diameter of the stocking blank. This section of the leg, between the dash-dot lines **146**, **147**, is adapted to engage the area of the knee of the wearer.

The medial section of the leg of the stocking, between the dash-dot lines **147** and **148** (FIGURE 11) is preferably knit with the same size stitch loops from course to course. In accordance with the present invention, the step-by-step movement of the graduating cam **92** (FIGURE 5) is interrupted as the control pin **137** moves into engagement with the roller **138** to lift the free end of the racking lever **95** out of racking engagement with the teeth on the rack wheel **93**. After the stocking has been knit down to the line **148** (FIGURE 11), the pattern drum **84** is moved a sufficient distance to release the racking lever **95** so that it will again engage the rack wheel **93** and impart step-by-step movement to the graduating cam **92** so that the size of the stitch loops being knit at each knitting station **10**, **11** is again gradually reduced by a gradual lowering of the needle cylinder **54**. This gradual reduction in stitch size is continued throughout the remainder of the leg portion **145** and down to the dash-dot line **149**.

At this dash-dot line **149**, the needles which knit the instep portion of the stocking are raised to inoperative position by the usual switch cams **23**, **24** and a heel pocket **150** is knit in a conventional single-feed manner, at the main knitting station **10**. The heel pocket **150** is knit by feeding a suitable heaver yarn to the needles, such as a 40 denier texture multifilament nylon yarn. The heel pocket is knit in the usual manner by narrowing and widening while the stitch loops across the instep are held on their idle needles.

Upon completion of the knitting of the heel pocket **150**, rotary knitting is resumed and the foot portion, broadly indicated at **151**, is then knit with the same stitch construction as the leg **145** and in a two-feed manner. It is preferred that the stitch loop size remain constan in knitting the foot portion **151**, and the regulation of the stitch size is then under control of the conventional size drum, not shown. After the desired length has been knit in the foot portion **151**, a run-stop band **152** is knit in the conventional manner. The toe pocket **153** is then knit in a single-feed manner and of a heavier yarn. The toe pocket **153** may be formed in any desired manner, and in the present instance, it is formed by knitting a single narrowed section and a plurality of looper's rounds or courses **154** are knit to complete the stocking blank.

The manner in which the stocking blank is fashioned during knitting by varying the stitch size in the manner just described provdes a better fit and a more efficient compressive force on the leg of the wearer after the stocking has been looped or the toe closed by any suitable means. It is preferred that the toe be closed by a curved seam, as indicated at **155** in FIGURE 12, and the shape is set in the stocking after it is boarded and finished in the usual manner.

Thus, by knitting the support stocking in the manner described, the elastic yarn E is fed under substantial tension to the selected needles and positively floated inside the non-selected needles because of the wide separation between the levels of the hooks of the selected needles and those which are not selected, this wide separation being accomplished by means of the special needle lowering cam **104** (FIGURE 1). This special cam **104** insures the positive floating of the elastic yarn and it is virtually impossible to knit the elastic yarn on needles where it should float.

By knitting the elastic yarn E over the ledges **59** and behind the nibs **58** of the sinkers **56** (FIGURE 9) at the auxiliary knitting station **11**, the sinkers are not withdrawn and again inserted in the usual manner so that the nibs **58** of the sinkers remain against and maintain tension on the stitch loops of the body yarn course which

was previously knit at the main knitting station **10**. Thus, the sinkers operate to maintain the fabric under tension at the auxiliary knting station **11** independently of the usual fabric tensioning means of the machine, usually suction. Therefore, the uniformity of the knit fabric is not dependent upon effective suction or tension being applied to the knit fabric.

Also, by drawing longer or looser stitches of the body yarn at the main knitting station **10**, by means of the sinker advancing means and the sinker cap retarding mechanism, a greater length of body yarn is incorporated in the stocking and a relatively lesser length of the covered elastic yarn E is incorporated in the stocking, so that there is more of the 20 denier monofilament body yarn present in the stocking to provide a more sheer appearance to the stocking. Since the elastic yarn E is fed under an abnormally high tension, about 10 grams, the needle cylinder is initially raised to a higher position at the beginning of the knitting of the leg porton **145**, to draw long stitches at both the main and the auxiliary knitting stations so that the length of body yarn incorporated in the stocking is substantially greater than normal. This method also allows a greater relative reduction of the stitch size, down to a very small stitch at the ankle, and maintains the proper length of the elastic yarn to the body yarn throughout the knitting of the complete stocking, whether the stitch size is being gradually reduced or is maintained the same.

The high tension applied to the elastic yarn increases the importance of the special feed finger **100** so that the yarn does not rub against the metal throat plate **44** and cause variations in tension and damage to the elastic yarn. With alternate straight and graduated sections in the leg portion of the stocking blank, as shown in FIGURE 11, a gradually upwardly decreasing compressive force is applied to the leg of the wearer. Thus, the upper portion of the leg is not constricted by the stocking and the compressive force is greatest at the ankle and gradually reduces up the leg so that the pressure on the veins in the leg is gradually reduced from the angle upwardly, thereby gently forcing the blood back up the leg of the wearer.

In the drawings and specification there has been set forth a preferred embodiment of the invention and although specific terms are employed, they are used in a generic and descriptive sense only and not for purposes of limitation, the scope of the invention being defined in the claims.

I claim:

**1.** A method of knitting an elastic support stocking, with at least the leg portion having an open mesh and highly sheer appearance and gradually upwardly decreasing compressive effect, on a multi-feed circular knitting machine having stitch forming instrumentalities, including a circle of needles, and sinkers supported for radial movement between the needles and having nibs with stitch drawing ledges in front of and behind the nibs, which method comprises the steps of

(a) feeding under a substantially small tension an inelastic yarn to all the needles at one yarn feed and lowering the needles to draw the inelastic yarn down in front of the nibs of the sinkers and advancing the sinkers at an earlier than normal position to form said inelastic yarn into knitted stitches of a selected, relatively large size,

(b) feeding under a relatively high tension an elastic yarn to alternate needles and floating the elastic yarn above intervening needles at the next successive yarn feed and maintaining the sinkers in the innermost position while lowering the alternate needles to draw the elastic yarn down behind the nibs of the sinkers and form said elastic yarn into knitted stitches of a substantially smaller size than said inelastic yarn stitches, and

(c) repeating steps (a) and (b) throughout the knitting of at least the leg portion, the knitting and floating of said elastic yarn being staggered between alternate and intervening wales from course to course, the relatively high tension on said elastic yarn reducing the amount of elastic yarn in the stocking and the relatively large size stitches of said inelastic yarn increasing the relative length of inelastic yarn in the stocking to thereby enhance the sheer appearance of the stocking.

**2.** A method according to claim **1**, wherein the elastic yarn is fed under a tension of about 10 grams in step (b).

**3.** A method according to claim **1**, wherein the elastic support stocking includes a turned welt at the upper end and a heel pocket at the lower end of the leg, and wherein the method includes maintaining the stitch size constant at both knitting stations and throughout the knitting of the portion of the leg immediately below the welt, gradually reducing the stitch size at both knitting stations throughout the knitting of the next adjacent portion of the leg, maintaining the stitch size constant at both knitting stations throughout the knitting of the next adjacent medial portion of the leg, and gradually reducing the stitch size at both knitting stations throughout the knitting of the next adjacent remaining portion of the leg, down to the heel pocket.

**4.** A method according to claim **1**, wherein the multi-feed machine includes a main knitting station and an auxiliary knitting station, the inelastic yarn being fed at the main knitting station and the elastic yarn being fed at the auxiliary knitting station to form a course of elastic yarn and a course of inelastic yarn with each rotation of the needle circle, selective needle raising means in advance of said auxiliary knitting station, and a needle lowering cam at said auxiliary knitting station and being operable to engage and lower the needles not raised by said selective needle raising means to provide a relatively wide separation between the raised and lowered needles at the auxiliary knitting station, said method including the steps of feeding the elastic yarn at a predetermined level at the auxiliary station, raising alternate needles sufficiently to pick up the elastic yarn while lowering the intervening needles well below the elastic yarn feeding level to cause a positive floating of the elastic yarn at the intervening needles during alternate rotations of the needle circle, and raising intervening needles sufficiently to pick up the elastic yarn while lowering the alternate needles well below the elastic yarn feeding level to cause a positive floating of the elastic yarn at the alternate needles during intervening rotations of the needle circle.

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