This invention is concerned with garments knitted by the so-called "seamless" or "circular" single needle knitting system with provisions for knitting plain jersey stitches either alone or including patterned areas such as fabric incorporating plain jersey stitches, tuck stitches (for purposes of this invention, a stitch formed when a knitting needle takes on one or more new loops while retaining the old loop, and then knits all off together) and floated yarn combinations. For purposes of this invention, the expression "jersey knit" shall include all such combinations. The invention is particularly concerned with "seamless" jersey knit garments incorporating elastic yarn inlaid into the fabric either to provide fit, to provide a therapeutic effect or to provide elastic stretch in an area where the body is permanently convex or at least is convex during body flexing. The invention is applicable to a wide variety of seamless jersey knit garments typical of which are stockings, anklets, socks and half hose in which the convex portion involved is the heel, elbow guards, knee guards and girdles in which the convexity is accentuated by flexing and other garments such as brassieres, bathing suits and the like where convex form fitting is involved. In all of these garments, unless provision is made for extra material where a pronounced convexity occurs, the garment tends to bind or at least is considerably distorted and poor fitting when worn. In the elastic stocking field the solution to the problem of providing extra material in the heel portion has proven so elusive that present methods are a compromise. Extra material is added in the convexity of the heel portion by reciprocation of the needle cylinder. Unfortunately it is not practical at present to inlay elastic yarn during reciprocation using the seamless knitting machine, so that when the heel portion is reached and reciprocation is begun, the elastic yarns are terminated. If the only disadvantage of heel reciprocation in the inlaid elastic stocking field were the slowness of the process, it might be accepted as it is in the ladies' seamless stocking field as an unavoidable consequence in obtaining well fitting heels. But when elastic yarns must be terminated and then introduced as in inlaid elastic stocking, the procedure requires very delicate operation techniques. A large proportion of defects in such stockings occur therefore in the area of the heel and instep. In other fields the problem of proper fit in one or more convex portions has caused jersey knit garments with inlaid elastic yarn to be considered inappropriate. For example, seamless brassieres with inlaid elastic yarns have not been provided although strapless brassieres are in demand.

It is an object of this invention to provide a variety of jersey knit garments wherein extra material is incorporated by continuous circular machine movement in a convex portion together with an uninterrupted inlaid elastic yarn.

It is an additional object of this invention to provide jersey knit garments with circular knit convex portion incorporation inlaid elastic yarn which garments are shaped to final limp form by thermal setting without destroying the elastic properties in the convex portions.

Other objects and advantages of the invention will be apparent from the specification and drawings.

In the drawings:

FIGURE 1 is an illustration of a typical jersey knit foot covering garment of the invention incorporating added material in the convex heel in which inlaid elastic yarn is continuous.

FIGURE 2 is an illustration of a typical jersey knit knee guard in which material is added in the knee area while elastic yarns are inlaid continuously through the area.

FIGURE 3 is a diagrammatic illustration showing how the elastic yarn continues through the convex area and how extra courses are added in the convex area. The illustration is directed specifically to a stocking step and heel but applies equally as well as to a seamless girdle.

FIGURE 4 illustrates diagrammatically how the invention is applied to a seamless brassiere in which elastic yarn is inlaid continuously throughout the band and extra material is added in the convexity of the cup portion. It is to be understood that in these diagrammatic illustrations the relationship of the elements is not realistic. The actual fabric is more clearly illustrated in the swatches of FIGURE 5 inclusive showing the elastic yarn inlaid in the knitted stitches.

FIGURE 5 illustrates an enlarged portion of fabric typical of the garments of this invention showing a combination of jersey stitches and tuck stitches.

FIGURE 6 is a modified cam ring layout for an A.M.F. machine showing the path of the needle butts in forming a convex heel in accordance with this invention.

The preferred method of terminating a course of the extra material added in the convex area is by a tuck stitch. With some yarns, however, particularly with knitted yarns such as Helanca, it is not essential to use a tuck stitch. With such yarns the adjacent severed tails intertwine particularly if they are left fairly long in the trimming.

At least two feeds are ordinarily used for inlaying elastic fabric. By the methods of this invention three feeds or more are used. For purposes of simplicity typical knitting operations will be described generally whereas more specific descriptions are given in the examples.

In a typical three feed stocking operation of this invention two feeds carry the welt yarns and the shadow welt yarns which are knitted in the usual manner for ladies' stockings. When the stocking boot is reached, one feed substitutes elastic inlay yarn while the other substitutes the yarn used in the structural stitches of the boot. The third feed which carries the yarn to be knitted as extra courses in the convex heel portion is dormant. Prior to inlaying, the elastic yarn is knitted into one or more stitches with the welt or boot stitches to lock it in at the end. Similarly, before the elastic yarn is removed at the ring toe it is moved from the inlay position to the knitting position and is knitted into one or more...
stitches with the boot or ring toe stitches. The boot of the garment is knitted in accordance with the now well known method described in my U.S. Patent 2,962,885 now reassigned as Re. 25,046. The present method differs from that described in my said reassigned patent by the fact that the heel is knitted by continuous circular machine movement rather than by reciprocation. Furthermore, at the point where the heel was initiated by removing the elastic yarn in my now reassigned patent, the elastic yarn is no longer removed but rather continues as preferably does the boot structural yarn into and through the heel pocket area. The amount of elastic yarn metered in is increased by about 1/2 inch over that metered in the ankle per round. Any of the well known yarn furnishing devices such as that represented in the Bourcet Patent No. 2,441,118 may be utilized in metering the elastic yarn. In addition, in accordance with this invention, a third feed comes into activity, knitting a partial course by continuous circular movement of the machine between the regular courses knitted by the other feeds. This partial course may be knitted off utilizing one of several devices well known in the knitting art. For instance, long and short boot needles may be used with the yarn missing the short boot needles in the instep portion and being knitted by the long boot needles in the heel portion. Or a clocking device may be employed which may be of any desired section of the machine. Alternatively, the individual needles may be controlled by a secondary pattern device operating in the heel section only. The extra courses alternatively may be merged in the instep stitches as tuck stitches using the well known tuck forming procedures such as long latch needles, pattern wheels, multi-cleaning keys, different lengths of jacks, etc. thereby spread again to form the next partial separate course in the heel area.

It is preferred where partial courses are added in the heel to terminate such courses with a tuck stitch, or two or more tuck stitches separated by a float or knitted individual stitch. The yarn floated across the instep is trimmed leaving yarn tails on each side where the heel commence. The added courses may be of a number of yarns. If a double hee is desired yarns similar to those used in the knitted stitches of the boot may be used in the extra courses. If a soft cushion with two-way stretch is desired, the added courses may be of stretch yarn such as Helanca. Where the latter yarn is employed the use of tuck stitches to lock the ends of the partial course is not required.

As an alternative to the above method, where the elastic yarn is laid in only every other course or, where more feeds are available, in every third or fourth course, all the feeds in the boot portion and with elastic yarn being laid in one course. When the heel and instep are reached one or more courses are eliminated in the instep while they continue in the heel portion, the course in which the instay is placed and the instay continuing in both the instep and the heel.

In some instances it may be desirable to utilize the principles of this invention by introducing elastic yarn only in the areas containing a pronounced convexity. For instance, in a streetwear ladies' stocking one may introduce elastic yarn at a point just prior to knitting the heel and remove it after the heel is completed. The heel area may then be knitted with inlaid elastic yarn and with added courses by circular motion. The elastic yarn in this instance would provide superior fit and stretchiness. Similarly, it might wish to inlay only in the bottom portion of a circular knit shirt or bathing suit adding partial courses in the convex portions only.

Referring once more to the drawings:

In FIGURE 1, the foot covering garment 10, only the foot 11 of which is shown, includes an instep 12, a heel pocket 13 in which the inlaid elastic yarns are continuous and in which the added material is incorporated by circular movement of the needle cylinder. The garment is shown with a ring toe 15 and a toe 14. Obviously for purposes of this invention it is immaterial whether there is any toe in the garment and the garment might be made with an open toe.

In FIGURE 2, the knee guard 20 includes a jersey knit portion 21, a back of the knee section 22, a portion 23 with added partial courses and welt 24 and 25. The elastic yarns are incorporated in courses either throughout the garment or from welt to welt in continuous fashion. The elastic yarn may be restricted to those courses which are common to the area 23 and to the corresponding back of the knee section, however.

In FIGURE 3, the diagrammatic figure 30 shows how the elastic yarns 34 continue throughout the heel and instep portion. It also shows how the added partial courses 35 are knitted between the courses in which elastic yarn is inlaid. In the area of the instep 32 and the foot 31, added courses do not appear. This gives a pronounced and definite shaping to the heel area. The same diagrammatic illustration may be applied to a girdle with the added material giving a two-way stretch effect, if a stretch yarn is used.

In FIGURE 4, one cup 43, a portion of the connecting link 41 and the body band 42 of a brassiere knitted in accordance with the invention may be shown. The suggested arrangement of the added courses 45 may be modified to change the contour of the cup. The elastic yarns 44 which, of course, are inlaid in continuous jersey knit courses, form with the knitted stitches a continuous elastic band which is properly contoured and which is self-supported. It is preferred where such garments are knitted of thermoplastic yarns such as nylon to give finished shaping to the cup portions by heat setting methods which are well known. The preferred elastic yarn for such garments is bare Spandex but the elastic yarn need not be thermoplastic and in fact where the knitted stitches are of a non-thermoplastic material such as wool, the shaping achieved by the combined action of the added courses, the elastic inlay and the natural conformability of knitted material, is wholly adequate.

While the illustration of FIGURE 5 shows elastic yarn in every course and normally this preferably would be a continuous yarn, multiple feeds with multiple inlaying feeds might be employed. Obviously, it one desired to inlay elastic yarn in every other course in the normal fabric and every fourth course in the convex fabric, the swatch would have an appearance similar to FIGURE 5 but with the middle elastic yarn eliminated. Obviously too, if one wished to knit most of the normal fabric with the elastic yarn inlaid in every other course, he could choose to have the elastic yarn in every other course of the convex portion and eliminate the extra course in the normal fabric between the elastic yarns which are common to both fabric portions.

In FIGURE 5, the swatch 60 shown from the inside represents an alternative transition structure from the convex fabric portion on the right to the normal fabric on the left. The elastic yarns 61 may either be a preferred continuous yarn or the continuous yarns of separate lifts. Likewise the yarns 62a, 62b, 62c, 62d and 62e may be one preferred continuous yarn or the continuous yarns of separate feeds. Again the added courses 63, 64 and 65 are knitted in the convex fabric portion and are tucked in two separated stitches as at 67 with the continuous yarn and knitted between the tuck stitches as at 68. Again the floated portion of these extra courses might wish to inlay only in the bottom portion of a circular knit shirt or bathing suit adding partial courses in the convex portions only.
laying elastic yarn, the cam ring layout was modified by making the left clear cam 98 adjustable, by inserting a divided cam 107 and by making the intermediate needles not clear cam 104 which was formerly triangular to make it adjustable by the addition of a movable auxiliary cam 105. Intermediate jacks are selected so that alternate intermediate jacks are raised by cam 104 with cam 105 down and thus raise the alternate needles to the tuck position when the needles are not raised by the intermediate jacks and hence the elastic yarn passes over their hooks. These intermediate needles are lowered to the level of the sinner nbs by the dividing cam 107. The path of the needle butts is indicated at 108, the path of the alternate needle butts at 109 and the path of intermediate needle butts at 110. At the right of the ring cam layout is shown the relationship between needle 91, the sinner 111, the intermediate jack 92 and the cylinder jack 93. Other parts of the layout which are named for orientation purposes are the center stitch cam 94, the right-hand needle lowering cam 95, the left-hand needle lowering cam 96, the center clear cam 97, the right-hand clear cam 98, the left-hand stitch cam 99, the right-hand picker 100, the left-hand picker 101, the dropper 102, the jack raising cam 103, and the needle lowering cam 106. For purposes of easy identification, the modifications necessary to convert the AMF machine so that it will knit stockings in accordance with this invention are indicated by letters a to o. These modifications are explained in Example II.

The preferred products of this invention are knitted with thermoplastic yarns such as nylon in the knitted stitches and utilizing thermoplastic elastic yarns such as bare spandex for the inlay yarn. After such garments are knitted over are stretched over a form and heat set to final shape. This heat-setting operation does not destroy the elastic properties of the inlay yarn. The heat setting temperatures of most knitting yarns are well known but if a new thermoplastic yarn is utilized whose heat setting temperature is not known. If this proves too slow to obtain proper setting, the setting temperature should be raised by increments until proper temperature is reached.

Garments which are knitted of non-thermoplastic yarn may not have the finished counter appearance of heat-set garments but in most cases the combination of elastic inlay, knitted stitches and added courses will give adequate shaping in the convex portions.

The garments of this invention may be made of very fine sheer yarns as in the manufacture of ladies’ stockings or they may be made of very much coarser yarns. The method of making a garment with yarns of intermediate coarseness is described in Example I.

Example I

The method of making a typical garment of this invention, a man’s below-the-knee elastic stocking with an unturned well and having a heel section in accordance with the invention, is given in detail below:

The machine chosen is the “Elba” model RME Special, a three-feed machine, one feed of which is constructed to inlay elastic yarn. This machine is manufactured by Harry Lucas, Gadelander Strasse 24-26, Neumuenster, Germany.

Starting with the separating courses, a 50 denier nylon yarn with 10 turns of S twist is introduced and 8 courses are knitted. During this period the left-hand elastic inlay feed cams, the right-hand knitting cams and the elastic furnishing device are out of action. After the separating courses are knitted, the left-hand elastic inlay feed mechanisms consisting of the jack draw down cam in the lower race, the sinner retracting cam, the inlay needle draw down cam and the elastic inlay finger are activated when the short butt needles have passed the left-hand inlay position and the cams are activated by the arrival of the long butt needles. At the same time the clutch for the elastic thread furnisher is activated to furnish about 8 inches of elastic thread to alternating selected needles on each revolution of the cylinder. The elastic thread might be a 280 denier Lyca or another spandex yarn.

Shortly before the long butt needles have reached the right-hand feed the operating cams for this feeding station are activated. The right-hand sinner cam is retracted, the right-hand stitch cam is advanced against the short butt needles and the two right-hand yarn fingers are introduced. The knitting yarns chosen might be one end of 70/2 ply Super loft nylon in the first yarn finger and one end of 200 denier nylon in the 2nd yarn finger. The 200 denier nylon yarn is added at the right-hand feed to produce a firm roll-resistant top welt. The stitch size is controlled by the right-hand welt control cam.

The firmness and roll-resistance is further improved by the retraction of the center feed clear cam and the simultaneous introduction of the jack clear cam in the lower race.

This activation occurs again at the juncture of the short and long butt needles and produces a paneled rible fabric with tuck stitches on alternating needles.

As the long butt needles approach the center feeding station the 50 denier nylon separating yarn is exchanged for a 70/2 denier Super loft yarn and with this final action the welt make-up is completed. The elastic furnishing device continues to provide about 8 inches of elastic yarn per cylinder revolution until about 50 rounds of elastic yarn have been knitted and the welt has been completed.

Just prior to the completion of the welt, the graduating device of the elastic furnisher is activated. The elastic yarn feeding speed is increased slightly to provide about 9 inches of elastic yarn per revolution of the knitting machine cylinder to accommodate the normal calf dimensions.

At the completion of the welt, the pattern wheel is introduced on the butts of the short butt needles. At the point where the short butt needles meet the long butt needles, the pattern wheel slides toward the cylinder and depresses every other needle. At the same time the jack draw down cam is taken out of action and all needle selection for the elastic inlay thread is accomplished by the pattern wheel depressing every other needle. In view of the fact that the cylinder contains an odd number of needles, the inlay needles chosen change on every revolution of the cylinder from odd to even numbers and from even to odd numbers.

At the completion of the welt, the jack clear cam is deactivated in the lower race and this leaves all needles in tuck position. The 70/2 Super loft yarn in the center feeding station is taken out of action converting the machine to single feed operation. At the same time the stitch graduating device is activated increasing the stitch size of the calf area slightly. As soon as the calf section has been completed, the size of the knitted stitch is gradually reduced until the desired stitch density is produced in the ankle area. The speed of the elastic furnishing device is gradually reduced until about 6 inches of spandex are supplied per cylinder revolution in the ankle area. The transition from the welt fabric to the ankle fabric covers approximately 380 rounds of the cylinder.

At this point the speed of the elastic furnisher is increased slightly to furnish about 6½ inches of spandex per cylinder revolution. The center feed clear cam is advanced sufficiently to clear the long butt needles only. At the same time additional 70/2 Super loft is introduced on all long butt needles through the single section of the splicing yarn finger controlled from a cam section attached to the outer sinner ring. This cam section activates the splicing finger on all short butt needles leaving a floated yarn section on the inside of the fabric which is later removed. This addition of the 70/2 Super loft on all long butt needles is continued for about 80 courses and provides sufficient fabric to form a well fit.
tting heel pocket. To seal off the trimmed ends of the heel fabric courses, I prefer to provide tuck stitches on the first and last needle or groups of tuck and float stitches alternating at the beginning and the end of the heel pocket panel.

After the completion of the heel pocket panel, the sole and the elastic furnishing device is reduced slightly to provide about 6 inches of elastic yarn per cylinder revolution. The center feed clear cam and the splicing finger with the 70/2 Superloft are taken out of action and the machine continues to knit the foot fabric in the same manner as that used during the knitting of the calf and ankle fabric.

When about 100 courses beyond the heel pocket panel are completed, the elastic furnishing device is activated and the amount of elastic yarn per cylinder revolution is gradually increased to reach about 7 inches by the time 120 additional rounds of foot fabric have been knitted and the ring toe position in the stocking has been reached.

At this point the center clear cam is introduced again. At the point where the long butt needles are cleared the 70/2 Superloft toe yarn is introduced on the center feed. The pattern wheel and the left hand down cam are taken out of action, the left-hand sinker control cam is advanced and the elastic yarn furnisher is deactivated. As the cylinder advances, the stitch cam and the yarn finger control cam for the right-hand feed are deactivated. The right-hand sinker cam is pushed in and this takes the right-hand feed out of action, but leaving the knitting machine prepared to knit the ring toe fabric. When about 30 courses are knitted, the main cam drum is moved again to prepare the machine for the manufacture of the toe fabric in the usual manner by reciprocation. The long butt needles are taken out of action and the clutch is engaged to put the cylinder into a reciprocating motion. The up-pickers deactivate one short butt needle on each side of the short butt needle panel on each reciprocation of the cylinder. After about 36 courses the needle dropper is introduced putting two short butt needles into action again on each reciprocation of the cylinder. The up-pickers continue to deactivate one short butt needle on each reciprocation.

After about 36 courses have been knitted, the long butt needles are pulled into action by the wing cam, the clutch returns the cylinder into a rotating movement and the loose course and the final rounds of the margin yarn are knitted in the conventional manner. After about 24 courses, the 70/2 Superloft toe yarn is exchanged for the 50 denier nylon separating yarn and the stocking knitting cycle is completed. The toe may be closed by looping or sewing.

It should be pointed out that on this stocking the toe pocket was knitted on the short butt needles. This manufacturing procedure places the toe closure of the stocking under the foot which is an important feature and eliminates the need for special attachments normally used on hosiery machines to place the toe closure under the foot.

**Example II**

Typical of very fine ultra sheer garments of this invention are the full length elastic ladies' stockings which may be knitted on various seamless hosiery machines equipped with auxiliary knitting stations. Two very popular machines of this type are the Scott & Williams KN-2 and the AMPF machine which may be obtained fitted with elastic yarn inlay devices. For those familiar with the manufacture of seamless hosiery, however, it will not be difficult to adapt a variety of seamless machines to inlay elastic yarn and to manufacture elastic stockings with modified heel pockets in accordance with this invention provided at least two feeds are available in addition to the elastic yarn inlaying feed.

For the purpose of this example, the Scott & Williams AMF machine equipped with a suitable elastic furnishing device and modified in certain respects as explained herein so as to have an elastic inlay feed and two additional knitting feeds is used.

In the manufacturing process involved the machine is prepared to perform the first operation, the "make-up," feed, and the activation of the controlled elastic furnishing device. The transfer jacks are pushed into the spaces of the deactivated knitting needles, the make-up yarn feeders are dropped into action furnishing yarns to the knitting needles selected as well as to the transfer jacks between these needles. For the purpose of this description I have chosen 50 denier nylon yarns with 10 turns 5 twist for the welt as well as the make-up yarns of the center and the left-hand feed. As soon as the selected knitting needles and transfer jacks have taken the make-up yarn, the transfer jacks are withdrawn and the knitting needles are drawn down by the center stitch cam. As the cylinder advances, all needles take the make-up yarn are raised to a clear position, the make-up and welt yarns of the left-hand feed are dropped into action and all knitting needles take yarn on the left-hand feed. All needles rise to a tuck height after leaving the left-hand feed.

As the needles reach the selecting point again, the same alternating needles are selected to clear their stitches and take yarn on the center feed again, but without the activation of the transfer jacks. These needles draw their yarn through the previous round when they pass the lower stitch cam. As the cylinder advances, all needles clear their stitches as they approach the left-hand feed. All needles take yarn on the left-hand feed, they go down under the left-hand stitch cam and return to tuck position. At the completion of the second revolution all needles are cleared by the jack raising cam. At this point the auxiliary make-up yarns are taken out of action and the make-up is completed.

As the needles approach the selection point, all cylinder pattern jacks rise over the jack raising cam and all needles are cleared by the intermediate jack clearing cam before they reach the center feed. At this point the machine is prepared to knit the welt fabric which consists of approximately 420 courses.

After the completion of the welt fabric, the machine is prepared for the transfer operation. Alternating cylinder jacks used for the make-up operation are raised again bringing these needles into a clear position through the intermediate jack clearing cam.

The intervening low needles are raised by the movable end cam in the needle race. At this point the transfer jacks have been moved out to their transferring position where the bows are directly over the needles rising on the movable end cam. The needles pass through the transfer jack bows which are withdrawn as soon as the needle hooks have cleared the transfer jacks and this operation has transferred the first course loops of the make-up to the alternating knitting needles. These alternating knitting needles are raised to a clear position where they join the needles cleared by the intermediate jack clearing cam. The transfer is completed and the knitting machine continues to knit with all needles on the center feed as well as the left-hand feed to produce the shadow welt which consists of approximately 120 courses.

At the completion of the welt, the knitting machine is prepared to produce the elasticized leg and foot portion of the elastic stocking. This preparation includes an exchange of yarns at the center feed, a change of stitch type and an exchange of yarns at the left-hand feed, and the activation of the controlled elastic furnishing device.

The selector drum is activated taking two racks on the selected knitting needles and transfer jacks and the make-up yarn fed into the knitting machine and the activation of the controlled elastic furnishing device.
every revolution of the cylinder. The pattern is set to select odd needles in one round and even needles in the next round. The selected needles remain in tuck position until they reach the center clear cam which has been raised to a low clear position. The remaining needles are raised to a high clear position through the action of the cylinder jaws and the intermediate jaws.

The yarn change on the center feed from the 50 denier nylon shadow wet yarn to the 30 denier nylon leg yarn takes place about 10 needles prior to the selecting point of the alternating needles. When this point approaches the center feed. All needles take the 30 denier nylon leg yarn and knit a conventional jersey fabric on that feed.

As the selecting point for alternating needles advances to the left-hand feed, the left-hand clear cam is taken out of action. The auxiliary intermediate jack clear cam is left in clear position until the selecting point for alternating needles is reached and at that point the auxiliary intermediate jack clear cam is lowered to leave the needle in a tuck position. The alternating needles not controlled by the movement of the intermediate jacks are lowered to the level of the anker ribs by a dividing cam placed between the left-hand clear cam and the left-hand stitch cam. The elastic finishing device is activated supplying the elastic yarn to the knitting needles at a rate of 10-11 inches lift length for each revolution of the cylinder.

The elastic yarn chosen for this example is a 100 denier spandex yarn but experience has shown this material to be inadequate in tensile strength when used in stitches alone to withstand the strain normally exerted on conventional sheer stocking fabrics. Approximately 10 needles ahead of the selecting point for alternating needles operating in tuck position, the elastic yarn is introduced on the left-hand feed.

The 50 denier nylon yarn used in the shadow wet is not removed from action until the left-hand stitch cam is raised and the stitch formation on the left-hand feed is converted from a knitting position to a tuck or infar position for the elastic yarn. At this time I have found it safe to remove the reinforcing shadow wet yarn on the left-hand feed, since in every stitch in which elastic yarn is knitted there is also the 50 denier nylon yarn.

The production of the elastized leg fabric continues for approximately 340 courses with the 10-11 inches of elastic yarn per revolution of the cylinder.

During the next 720 courses the elastic yarn furnishing device gradually reduces the amount of elastic yarn furnished to the needles until it finally reaches about 6 inches per cylinder revolution in the ankle area.

At the same time the fashioning device is activated lowering the cylinder and reducing the stitch size drawn by the knitting needles gradually until the desired stitch density is reached in the ankle area.

Approximately 1000-1100 courses from the activation point of the elastic yarn furnishing device it is normal to cut off one of the conventional heel pockets by reciprocating the needle cylinder and the activation of the needle pickers and the needle dropper.

This reciprocating operation, as has been indicated earlier, is the cause for many defects in elastic hosiery knitted on conventional hosiery machines. It is even more subject to the creation of stocking defects, mens and waste on multi-feed knitting machines such as the AMF Knitting Machine.

When the left-hand feed is utilized for inlaying the elastic yarn in the heel section and the center feed is used for knitting the courses into which the elastic yarn is laid, there is normally no provision for knitting the extra courses in accordance with this invention on the AMF machine. I have discovered, however, that the AMF machine may be changed so that such extra courses may be knit through the modification of certain needle and sinker cam sections and the addition of an auxiliary yarn feeding finger. Referring to FIGURE 9, the right-hand stitch cam a normally used for the reverse stroke of a conventional heel or toe knitting operation is modified on its right side so as to be symmetrical with the left side. At the same time an auxiliary raising cam b is provided. Two other auxiliary cams are also provided; the cam c raises the needle group which has knit under stitch cam a and returns all needles to their original race at the center feed. The other cam is the low clear cam d which clears the latches of all .338 inch and .390 inch butt needles but not the .300 inch, the .270 inch and the .240 inch butt lengths. In addition, an auxiliary yarn feeding finger e is furnished.

This arrangement permits the introduction of an additional course or part course and in reality converts normal 2-feed operation, one of which is inlaying elastic yarn on the AMF machine to a 3-feed operation two of which are knitting.

In preparing for the heel pocket the speed of the elastic thread furnisher is increased to supply about 7 inches of elastic yarn for each revolution of the cylinder to allow for the normal dimensional requirements in the heel and instep area.

Low clear cam d is introduced clearing the latches of all .338 inch and .390 inch butt needles except the tuck needles, i.e. long latch needles, but not the .300, 270 and .240 inch butt lengths. Intermediate jack cam f is withdrawn. As the cylinder advances another yarn is introduced by auxiliary yarn feeding finger e. The yarn chosen might be a 20/2 Superloft nylon yarn. This yarn finger performs the function of a splicing yarn finger, that means, it provides a 20/2 Superloft nylon yarn to certain selected needles or needle groups, that is the .338 and .390 inch butt needles.

Specifically, in this example, tucking is performed by the use of two long latch needles at either end of the heel panel, each pair being separated by normal needles.

The needles are raised to receive yarn by low clear cam d. The stitches are drawn by modified stitch cam a whereupon auxiliary cam c raises the needle group to clean-cam 97 level at high clear and returns all needles including the tuck needles to their original normal race at the center feed. All needles are cleared.

This modified 3-feed operation is continued for about 160 courses, and the heel pocket is completed without interference of the normal knitting operation at the center or the left-hand feed. The alternating needle selection and laying-in of the elastic thread is continued in the usual manner.

After the heel section has been completed cam sections a, b, c, d and f are returned to the original leg position and the auxiliary yarn feeding finger e becomes inactive. The elastic thread furnishing device returns to the ankle position providing about 6 inches of elastic thread per cylinder revolution and this feeding position of the furnisher is maintained for about 150 courses. At this point the thread furnishing speed is gradually increased to provide about 8½ inches of elastic thread by the time about 100 additional courses have been completed and the knitting machine is prepared to produce the ring toe stocking section.

The ring toe fabric is produced with 50 denier nylon on both the center and left-hand feeds. This means that both yarns used in the foot portion will have to be exchanged and the stitch type on the left-hand feed will have to be changed from tuck or infar stitch to single stitch. The cylinder pattern jacks are taken out of action and the selector drum is stopped. As the cylinder advances to the center feed the 30 denier nylon is replaced with the 50 denier nylon toe yarn about 10 needles before the selector drum has stopped to divide the needles. As the cylinder advances to the left-hand feed the 50 denier nylon is introduced at that position. The auxiliary clear cam for the intermediate jacks on the left-hand feed is raised to a high clear position and this action is followed by the raising of the left-hand clear cam. This
3,241,340 cam change takes place on divided needles. In the final move the elastic yarn is taken out of action and the elastic thread furnishing device is stopped.

The knitting machine continues to knit in rotating position for at least 8 courses to complete the ring toe fabric.

In the conventional knitting process the machine would now produce a toe pocket on the long butt needles to permit a toe closure under the foot.

In view of the fact that the heel pocket was knitted on the long butt needles the toe section can now be knitted on the short butt needles without sacrificing the toe closure under the foot.

In preparing for the toe pocket the long butt needles are raised to be out of action. The clutch changes the cylinder from rotary to reciprocating motion. The center and left-hand clear cams move into low clear position.

The left-hand reverse stroke needle lowering and raising cams are moved into action. The right-hand reverse stroke stitch cam is moved into action and the lowering cam is moved out of action. Finally the raising switch cam is moved out of action and the auxiliary raising cam is moved into action. The clutch shifts the cylinder movement from rotary to a reciprocating movement. This completes the going into the toe which prepares the knitting machine to knit the toe fabric on the short butt needles. The machine stops with the short butt needles in front of the machine. The left-hand lifter is in position to engage the first two short butt needles when the cylinder makes its first clockwise reciprocation. As the direction of the cylinder reverses the right-hand lifter deactivates two short butt needles from the opposite needle section. This deactivation of the short butt needles continues until about ½ of all short butt needles remain active.

For the purpose of this example, I have chosen a conventional straight gore toe pocket. This calls for the activation of the needle dropper at the time ½ of the short butt needles are still active. When this point of the toe pocket is reached the lifter is raised slightly to deacti-vate one needle only on each reciprocation. The activated dropper lowers 3 needles on each cylinder reciprocation. This action is continued until all short butt needles are returned to a knitting position and the toe pocket has been completed. The clutch changes the cylinder movement from a reciprocating to a rotary movement. The draw down cam returns all needles to an active knitting position. It is the usual practice to knit two courses of plain fabric with the toe yarn before the change is made to single feed knitting which is described in detail in the instruction manual for the AMF machine. It includes the eyelet closing procedure, the knitting of the loose course, the hopper rounds and the introduction of the margin yarn which is done in the conventional manner suggested by the manufacturer of the AMF machines.

The completed stocking is dropped out of knitting needles and is blown into the receiver tube. The knitting process is completed and the machine returns to Phase No. 1 to the make-up for a new stocking.

The preferred garments of this invention utilize elastic yarns which are thermoplastic, such as spandex. But other thermoplastic and non-thermoplastic elastic yarns including natural and synthetic Vulcanized rubber yarns and elastomeric forms of other polymers and/or copolymers including but not restricted to those of the polyamide, halogenated polyethylene, polyester and polyvinyl types are suitable as the elastic yarns in the garments of this invention. It is preferred to use these elastic yarns in multifilament form but monofilament yarns are suitable and in some cases may be more readily obtainable. It is also preferred to use such elastic yarns in the uncovered condition but elastic yarns covered with one or more helical or other extendable coverings are satisfactory. For purposes of this invention elas-
tic yarn shall mean a yarn which is capable, after being stretched momentarily to 125% of its untensioned length, of substantially returning to that untensioned length with-in a period of two minutes if constrained. This definition is intended to include yarns which are not inherently elastic, that is, not of elastomeric material. For certain light garments where fit is the primary requirement such yarns which have the requisite elasticity because of the method of manufacture, arrangement or physical chemical or other treatment are satisfactory. One should be careful, however, where thermoplastic heat forming of the garment is involved that the elasticity of the yarn is not destroyed particularly where the yarn is elastic because it has been heat set in its manufacture in knitted, curled, twisted or other non-linear form. In such case, in heat-setting the garment one should not exceed the temperature originally used in heat-setting the yarn.

It is not essential that the elastic yarn be inlaid in every course of the normal fabric for purposes of this invention, although in most instances that is preferred. The invention is, however, particularly useful in very fine garments where it is particularly desired that the entire garment be elastic and in some instances the entire garment may be inlaid as little as one course in 10. Obviously, the effect of the elastic yarn is much greater when it is closer together in adjacent rounds and for some purposes such as in therapeutic garments which also may be very fine, it may be desirable to inlay the elastic yarn in every course or in every second or third course. It is to be understood that in the con-vex portion where courses are added, the elastic yarn will be still further separated.

With regard to the knitted structural yarns of the gar-
ments of this invention, all of the normally utilized yarns for knitted garments are they natural or synthetic are suitable, thus silk, cotton, wool, rayon, nylon and the multitude of synthetic yarns are satisfactory for the garments of the invention. When the garment is to be fin-
ally shaped by thermal setting, it will be necessary, of course, to use a thermoplastic yarn such as nylon or the like in the area to be thermally set. But in many in-
stances thermal setting is neither warranted nor required.

Novelty yarns including various stretch yarns may be used as desired. Combinations of various yarns and combi-
inations of various structures may be used and such are included provided such garments include a circular knit seamless band including an elastic yarn inlaid in a gene-
ral spiral course of jersey-knit stitches of the band and an additional course of jersey-knit stitches between and separating adjacent turns of the spiral course in a portion less than the circumference of the band.

1 claim:
1. A tubular elastic-yarn-containing garment comprising jersey-knit stitches of thermoplastic yarn forming spiraloid courses of said garment including at least one area forming a convex projection from the tubular walls of said garment, an elastic yarn extending in a spiraloid winding inlaid in at least one of said spiraloid courses of jersey-knit stitches, adjacent rounds of said elastic yarn being separated in said convex projection by at least one additional unreversed course of stitches forming less than a complete circumferential round of said garment, said elastic yarn being present in greater amount in the rounds partially included in said convex projection than in the rounds closely adjacent said projection but not included therein.
2. The article of claim 1 wherein the garment is a girdle.
3. The article of claim 1 wherein the garment is a brassiere.
4. The article of claim 1 wherein the garment is a joint protective garment.
5. The article of claim 1 wherein the elastic yarn is a spandex yarn.
6. The article of claim 1 wherein the garment is a
foot covering garment and the convex projection is the heel portion of said garment.

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