May 13, 1969 H. KNOHL 3,443,404

CIRCULAR-KNIT ELASTIC FOOT GARMENT WITH NONBINDING INSTEP

Filed Sept. 19, 1967

Fig. 1.

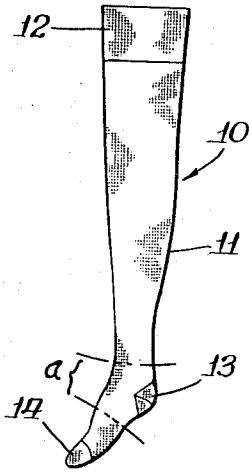


Fig. 2.

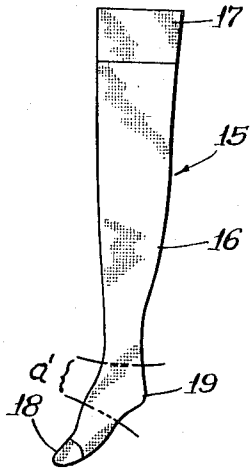


Fig. 3.

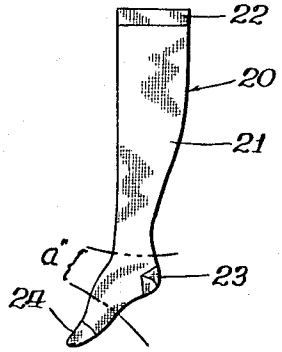


Fig. 4.

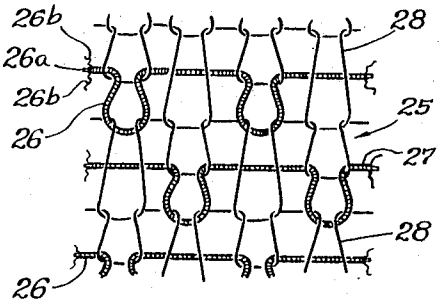


Fig. 5.

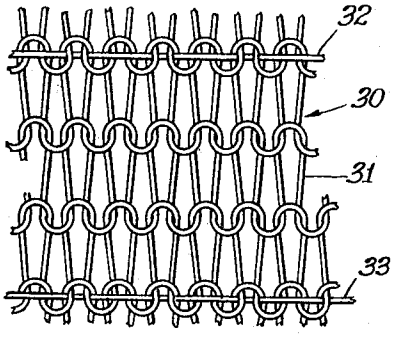


Fig. 6.

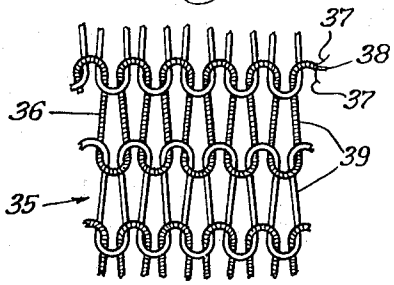
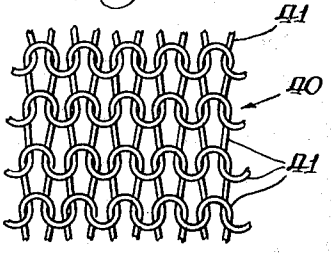


Fig. 7.



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CIRCULAR-KNIT ELASTIC FOOT GARMENT WITH NONBINDING INSTEP

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Int. Cl. D04b *11/06*
U.S. Cl. 66—178 7 Claims

ABSTRACT OF THE DISCLOSURE

This invention is particularly concerned with circular-knit foot garments such as socks, over the calf stockings, over the knee stockings, and full length stockings, including normal streetwear stockings, support stockings and therapeutic stockings, all having an instep area of courses with gradually increased stitch size and another instep area of courses toe-ward of the first area with gradually decreased stitch size.

This invention is concerned with circular-knit foot garments such as stockings, as contrasted to full-fashioned foot garments.

BACKGROUND OF THE INVENTION

Full-fashioned stockings such as those illustrated in U.S. Patent No. 2,181,836 to Otto F. Smetana, and U.S. Patent No. 2,883,842 to Herbert Knohl, generally fit very well in all areas. There is no problem with such stockings in providing increased capacity to stretch where that is desirable in a particular area since the number of stitches in the blank width may be increased in the area. Because all of the stitches are of the same size, such localized increased extensibility may be provided without visible appearance variability such as differences in shading.

But circular-knit stockings excluding those of the type illustrated in U.S. Patent No. 2,809,509 to B. T. Reymes Reymes-Colee have the same number of stitches in the small round of the ankle portion as there are in the very much larger round of the upper thigh portion. The difference in size is achieved by changing the stitch size with the stitches being so gradually decreased that variations in shading are not objectionable.

However, when circular-knit foot garments have fitted ankles, a problem arises with regard to the instep-heel area since there occurs a very significant and very abrupt increase in circumference in the human foot from the ankle to midheel. The problem, although known to exist, has never been adequately solved, and circular-knit stocking machines universally have been provided with stitch cams which do not vary the stitch size in the instep area from those in the ankle area.

Some circular-knit stockings, particularly support stockings, have been knitted loosely from top to toe, reflecting an effort to avoid instep binding, so that until the garment is vertically tensioned as by a garter, it fits very loosely, particularly in the ankle area. Other stockings made to fit in the ankle have relied on modified stitch size and stitch distortion provided in the boarding process and upon the reciprocated heel to provide increased material. However, an average foot with an eight inch circumference ankle measures twelve inches across the instep and around the ball of the heel. I have found that circularly knitted stockings with a good ankle fit are universally lacking in extensibility in the instep area regardless of the type of heel and despite modification and distortion on the boarding form. The boarding process produces stockings in which the stitches in the instep area are reduced in size and somewhat spread in the circumferential direction so

that although the stocking fits very snugly in the instep area when the ankle is in repose, there is little excess stretch left.

When the instep is active, as in walking, the skin on the forward stride is stretched with the foot and ankle, making an obtuse angle; then as the foot passes relatively under the body and to the rear with the foot and ankle making an acute angle, the excess skin forms into folds. When the instep area of the stocking is very snug fitting and there is little residual circumferential extensibility, the stocking conforms into the wrinkles, thus becoming unsightly and frequently uncomfortable.

These deficiencies of circular-knit stockings are very much emphasized in garments which contain elastic yarns running in a coursewise direction unless the elastic yarn is very loosely incorporated.

SUMMARY OF THE INVENTION

I have found that circular-knit foot garments may be knitted with stitches which are of proper size to give a well fitting ankle but in which increased extensibility is provided in the instep-heel area by a gradual increase in knitted stitch size to the midpoint of the heel followed by a gradual decrease in knitted stitch size through the heel. Considerable extensibility in the instep area remains after the boarding process, the binding effect in the instep being substantially eliminated. Furthermore, when foot garments of this invention are vertically tensioned either by an elastice supporting garter or by vertical elasticity in the garment itself, the garment does not conform to the instep wrinkles or folds but rather tends to bridge the folds.

In a normal circular-knit stocking where the stitches in the instep are all of similar length to those in the ankle, the appearance is very even as the garment comes from the machine. But when the stocking is boarded and the bend of the instep is formed, the courses are realigned and the stitches become smaller in the front portion of the instep so that in the front portion the courses are positioned in closer proximity to each other while the same courses with the stitches larger are positioned farther apart toward the heel. The stockings of this invention, however, have courses in the instep which are knitted gradually longer to the midpoint of the instep. When the bend in the instep is formed in boarding, the reduction in stitch size and the distance between courses in the front portion of the instep as realigned are very similar to the stitch size and the distance between courses in the ankle so that the boarding process makes the instep area quite inconspicuous on the counter and on the wearer. Where the stocking is an elastic stocking in which the elastomer sets the tone, the difference in the area is very difficult to detect.

In accordance with this invention, the knitted stitches in the instep area may be increased without conspicuous appearance differences if the increase is done carefully and gradually. Stitch graduation is normally accomplished on the typical circular knitting machine through the use of a stitch graduating segment. The modified instep portions of garments of this invention are produced in the same manner by utilizing an extended stitch graduating segment with an appropriate shaped stitch graduating cam surface. All portions of the garments of the invention up to and including the ankle portion are knitted in the usual manner except that when the ankle is reached, the stitch graduating segment is deactivated until the instep portion is reached about an inch and half to two inches before the heel is knitted on a reciprocating machine and at about the same point on a continuous circular knit machine which normally provides a heel patch. When the instep portion is reached, the stitch graduating segment is reactivated. As the new extended stitch graduating seg-

ment is advanced gradually to draw increasingly larger stitches with the added camming surface of the stitch graduating cam rising about .005" while one-and-a-half to two inches of fabric is produced and then declining at the same gradual rate. When the activation of the reciprocating heel movement is reached, the stitch control segment is deactivated to permit use of the normal reciprocating heel stitch control cam in producing the heel pocket. When the heel pocket is completed, the elongated stitch graduating segment is reactivated to the original cylinder elevation at the midpoint of the instep where it was before being deactivated for the heel movement. The stitch control segment continues to advance but the cam surface now is declined to gradually lower the needle cylinder from the point where the largest stitches of the instep were produced to the point where the smaller stitches of the foot area are needed. Such a gradual change in the stitch size makes the instep area inconspicuous when the stocking is in the finished form or when it is worn. On a non-reciprocating machine, no deactivation of the stitch graduating segment is needed.

When the stocking being produced has an inlaid or knit and float elastomer, the spandex variable control cam is changed to cause more elastomer yarn to be furnished to the knitting machine in the instep. The yarn furnisher illustrated in the James T. Cargill Patent No. 3,209,558, may be utilized as is illustrated.

BRIEF DESCRIPTION OF THE DRAWINGS

FIGURE 1 is a typical stocking of the invention **10** with a boot **11**, a turned welt **12**, a reciprocated heel **13**, and a toe **14**. The area *a* indicates the general area in which increased extensibility is provided.

FIGURE 2 is another typical stocking of the invention **15** with a boot **16**, a turned welt **17**, a toe **18**, and a continuously circular-knit heel **19**. The area *a'* indicates the general area in which increased extensibility is provided.

FIGURE 3 is a typical below the knee stocking of the invention **20**, with a boot **21**, a turned welt **22**, a reciprocated heel **23**, and a toe **24**. The area *a''* indicates the general area in which increased extensibility is provided.

FIGURE 4 is a typical modified jersey fabric **25** of the stockings of the invention in which alternate courses are of elastomeric yarns **26** knitted as knit and float courses with coverings **26***b* over core **26***a*. Intermediate jersey knit courses **28** are of substantially non-elastic yarns such as cotton, rayon, nylon and polypropylene. Elastomeric yarns with single coverings may be substituted for the double covered yarn **26**, or yarn **26** may be completely uncovered.

FIGURE 5 is another typical fabric **30** of the stockings of the invention, with knitted jersey stitches of substantially non-elastic yarns **31** into which elastomeric yarns **32** and **33** are inlaid. The yarns **32** and **33** may be either covered or bare.

FIGURE 6 is another typical jersey fabric **35** of the stockings of the inventon in which covered elastic yarns **36** consisting of coverings **37** wound in opposite directions about the elastomeric core **38** are in alternate courses while the intermediate courses **39** are of substantially non-elastic yarns. Bare elastomeric yarns or elastomeric yarns with other coverings may be substituted for yarns **36**.

FIGURE 7 is another typical jersey fabric **40** of the invention, comprising plain jersey courses **41** of substantially non-elastic yarn such as nylon, polypropylene, cotton and rayon.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Example 1

Using a typical two feed hosiery machine equipped to make reciprocated heels and toes, such as a Scott & Williams KN type machine, and using typical streetwear stocking yarns such as 40 denier multifilament nylon yarns in the welt and afterwelt, 15 denier monofilament nylon yarns in the boot and 40 denier multifilament heel and toe yarns, a streetwear stocking similar to FIGURE 1 and with fabric similar to that illustrated in FIGURE 7 was knitted in the usual manner down to a distance one and one half to two inches short of the point where the heel is commenced. At this point the extended stitch graduating segment was reactivated and the knitting continued with the knitted stitches being drawn gradually longer down to the midpoint of the instep, at which point the stitch graduating segment was deactivated and the knitting mechanism for knitting the heel was activated. The heel was knitted by reciprocation in the usual manner, after which the extended stitch graduating segment was again activated, the cylinder being raised to the point where it was when the stitch graduating segment was deactivated and then gradually lowered to gradually shorten the stitches to the size of the ankle stitches, whereupon the stitch graduating segment was deactivated. The foot was completed in the usual manner. A streetwear stocking with improved circumferential extensibility in the instep area resulted.

Example 2

Using a typical four feed tubular machine such as the Singer Fidelity LBMF model and using the same yarns except for the heel yarn as in Example 1, a typcial tubular knit stocking of the invention similar to that shown in FIGURE 2 and with boot fabric similar to that of FIGURE 7, was produced. Knitting proceeded in the usual manner to a point about one and one half to two inches short of the normal heel patch. At that point, in accordance with the invention, the extended stitch control segment was activated. The extended stitch control cam is so constructed that the stitches are gradually lengthened to the midpoint of the heel and then are gradually decreased in size until they are the size of the ankle stitches. Obviously, the stitches in the heel which are of the same yarn are also increased and decreased with the other stitches. The stocking was finished in the usual manner. After boarding, the resulting tubular streetwear stocking had improved circumferential extensibility in the instep area.

Example 3

A stocking of the invention resembling FIGURE 1 of the support type, having a boot of fabric similar to FIGURE 4, and incorporating a covered spandex yarn in the boot portion and foot except in the heel and toe, was knitted using the same machine and the same yarns as in Example 1, except that one of the boot yarns was replaced by a 40 denier spandex yarn covered with a single covering of 30 denier 26 filament nylon of the type illustrated in my patent, U.S. No. 3,301,018. This yarn must be kept under tension and should be fed to the machine by a metering device. The yarn furnishing device used in producing this example was of the type illustrated in the James T. Cargill patent, U.S. No. 3,209,558.

The welt and afterwelt were knitted in the usual manner. After exchange of yarns to boot yarns, the machine was set to knit at the nylon feed and to knit on alternate needles and float at intermediate needles at the feed introducing the spandex yarn. The adjustable cam on the furnishing device was set to meter in spandex at a rate to give the stocking appropriate support function and shaping with the stocking boot as it came from the machine measuring twelve inches in circumference at the welt and gradually reducing to ten inches circumference at the calf and to seven inches circumference in the ankle. The machine reduced the stitch size in the usual manner from the welt to the ankle area.

At a point one-and-a-half to two inches short of the

heel, the extended stitch control segment was activated and the stitches were gradually increased to the point where the heel was knitted. At the same time the spandex furnishing device was set to gradually increase the amount of spandex metered to the machine until at the heel the boot measured nine inches in circumference as it came from the machine in contrast to the seven-inch circumferenec at the ankle. At the heel the extended stitch control segment and the spandex yarn furnisher were deactivated and the heel was knitted with heel yarn in the usual manner by reciprocation. After completion of the heel, the extended stitch control segment and the spandex yarn furnisher were again activated making stitches of the same size and with the same amount of spandex as when deactivated for knitting the heel. The extended stitch control cam reduced the stitch size gradually down to the size of the stitches in the ankle. Likewise, the spandex yarn furnisher reduced the spandex gradually until the fabric measured seven inches in circumference. Thereafter no change in the spandex yarn furnished was made until the spandex was taken out for toe yarn. Likewise the stitch size remained constant and the stocking was finished in the usual manner. After boarding in the usual manner, the stocking had the usual properties of elastomer containing support stocking but had increased circumferential extensibility in the instep area.

Example 4

Using the same machine as in Example 2 and using the same yarns as in Example 3 except for the heel yarn and with two of the four feeds supplying spandex yarns and two nylon yarns in the boot and in the foot except the toe, a tubular knit support stocking of the invention similar to FIGURE 2 was knitted. The welt and afterwelt were knitted in the usual manner. The spandex was introduced in a knit and float construction similar to that shown in FIGURE 4 in alternate courses with courses of knitted nylon. The spandex yarn was metered in to give the same dimensions to the stocking as in Example 3 and the extended stitch control segment was introduced at the same place. But since the fabric of the heel was similar to that of the boot and it was knitted circularly, the extended stitch control and the spandex yarn furnishing device were not taken out of action. Thus the spandex was gradually increased to the midpoint of the heel by the furnisher and then gradually decreased. Likewise the length of the stitches was gradually increased ot the midpoint of the heel and then decreased to the point where the stitches were of similar length and the fabric had the same circumference as in the ankle. When the heel was commenced, however, the needles at the spandex feeds were all raised to knit during the heel sector of the needle circle but in the instep sector alternate needles did not rise. A partial course of spandex knit stitches and floats was thereby produced in the instep sector and a partial course of spandex all knit stitches in the heel sector. After the heel was completed, the entire course round of spandex yarn was knitted to the toe with alternate knit and float construction. The course rounds in the toe were knitted in the usual all knit construction of toe yarns. The stocking after boarding had improved foot shaping and the instep area had increased extensibility.

Example 5

Using the machine of Example 4 and the yarns but in different boot arrangement, a support stocking of the invention of the type shown in FIGURE 2 and with boot fabric similar to that shown in FIGURE 5 was knitted. The welt and afterwelt were knitted in the usual manner. The inlaid yarn shown in FIGURE 5 was metered in as in Example 4, being incorporated into the boot fabric by well known needle and sinker movements. The boot was knitted with sufficient spandex being metered in to attain the dimensions recited in Example 3. The stocking was again knitted to a point about one-and-a-half

to two inches short of the heel, at which point the extended stitch control segment was activated. at the same time the elastic yarn metering control cam was adjusted to gradually increase the spandex as in Example 4, and the stitch size was also gradually increased both to the midpoint of the heel. When the heel was commenced, however, the needles controlling the inlay both alternate and intermediate were controlled to knit the spandex yarn in the heel sector only. In the instep sector the spandex yarn was controlled so as to be inlaid. At the midpoint of the heel, the extended stitch control cam commenced gradually to reduce the stitch size to ankle stitch size while the furnisher also reduced the amount of spandex to make a fabric of similar circumference to the ankle dimension. When the heel was completed, the entire round of spandex was again inlaid. Thereafter the remainder of the foot was knitted to the toe without change. When the toe was reached, toe yarns replaced the boot yarns. The stocking was finished in the usual manner with all knit courses of toe yarns. After boarding, the finished garment had superior heel and foot shaping with increased extensibility in the instep area.

Example 6

Using the same machine as in Examples 2 and 4 and the same yarns as in Example 4, a support stocking of the invention was knitted. The garment differed from that produced in Example 4 in that one of the two spandex yarns was incorporated as an inlay yarn while the other continued to be incorporated in alternate knitted stitches and floats. The two spandex yarns were furnished by the same yarn furnisher in the same amounts, their incorporation being controlled by well known needle movements. It may be desirable in some instances in practicing the invention to control stitch length to accommodate both the inlay and the knit and float spandex furnished. Obviously two furnishes might be utilized so that each can be adjusted independently of the other. As in Example 4, all of the needles knitted in the heel sector while in the instep sector the spandex was respectively inlaid and formed into a knit and float course. The stocking was otherwise knitted and finished as in Example 4. This stocking had an excellently shaped foot and enhanced extensibility in the instep area.

I claim:

1. A circular-knit non-rib elastic foot garment including one or more courses of nonelastomeric yarn distributed throughout the garment and including one or more covered elastomeric yarns, elastomeric yarn being the sole yarn in any stitches thereof, the knitted stitches of said garment gradually decreasing in stitch size with a corresponding reduction in elastomeric yarn per circumferential round from a point above the ankle to the ankle, a gradual increase in knitted stitch size with a corresponding increase in elastomeric yarn per circumferential round from the ankle to the midpoint of the instep and a gradual decrease in knitted stitch size with a corresponding reduction in elastomeric yarn per round from the midpoint of the instep to a point between the heel and toe.

2. The products of claim 1 wherein the garments are stockings with an elastomeric yarn forming knitted stitches in the boot of the garment.

3. The products of claim 1 wherein the garments are stockings incorporating an inlaid elastomeric yarn in the boot of the stocking.

4. The stocking of claim 2 wherein the knitted stitches of elastomeric yarn occur in courses of alternating knit stitches and floats.

5. The products of claim 1 wherein the garments are men's below the knee stockings.

6. The products of claim 1 wherein the garments are over the knee length stockings.

7. The stocking of claim 1 wherein at least one course of jersey knit stitches and less than four courses separate the incorporated elastomeric yarn.

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U.S. Cl. X.R.

66—185, 186, 189, 190