Nov. 16, 1965 S. J. WIKLER 3,217,336

KNITTED FOOTWEAR

Filed Nov. 29, 1963 2 Sheets-Sheet 1

FIG. 1A

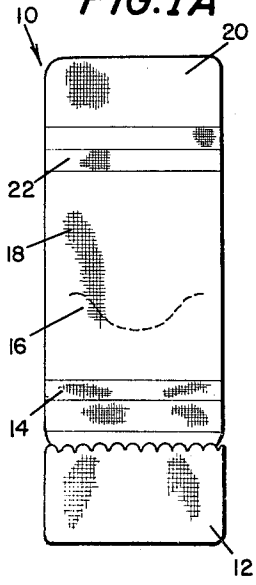


FIG. 1B

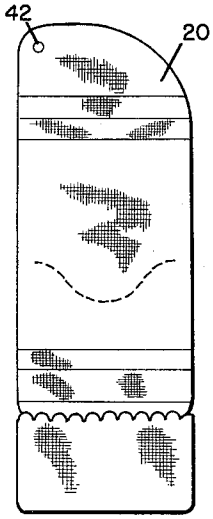


FIG. 1C

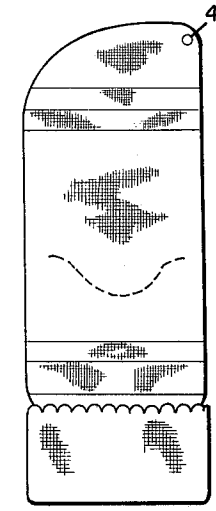


FIG. 2 PRIOR ART

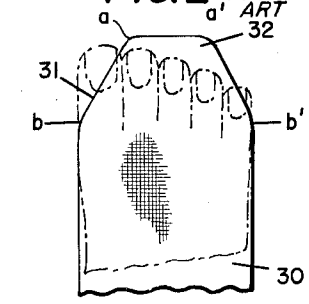


FIG. 11 PRIOR ART

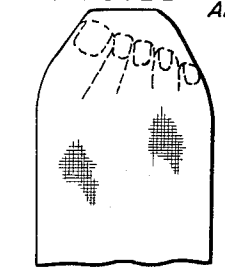


FIG. 3

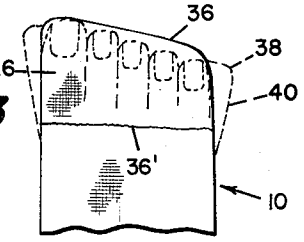


FIG. 4

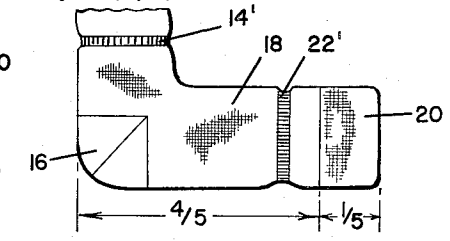


FIG. 5

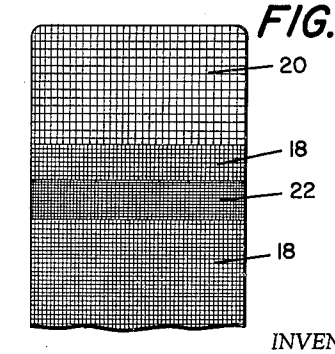
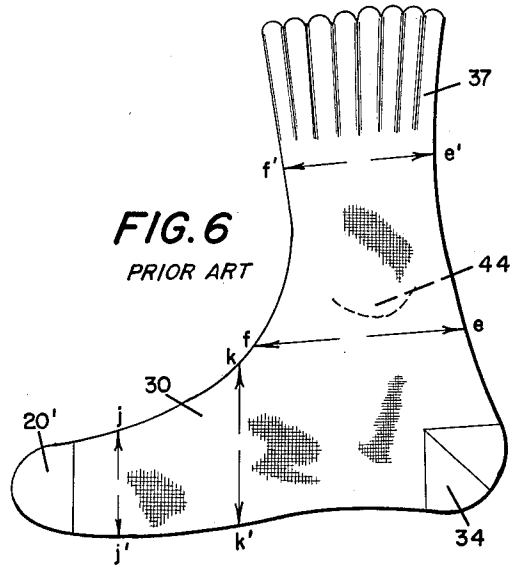


FIG. 6 PRIOR ART



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KNITTED FOOTWEAR

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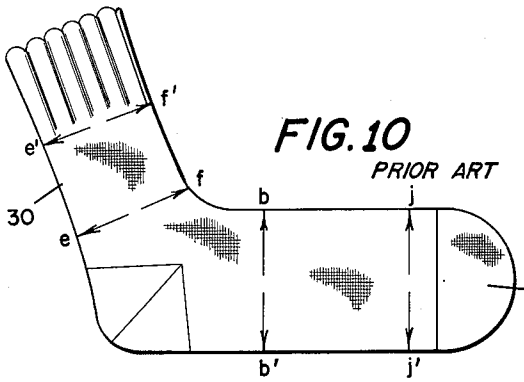

FIG. 10
PRIOR ART

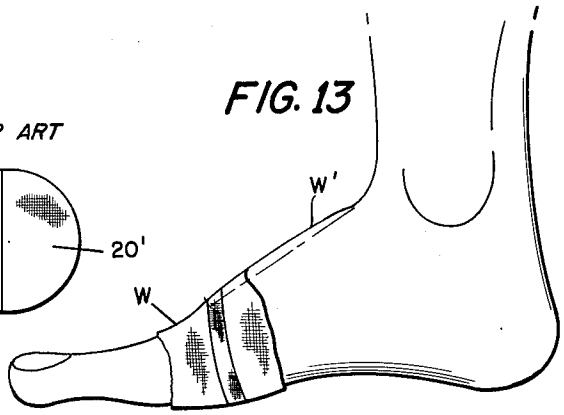

FIG. 13

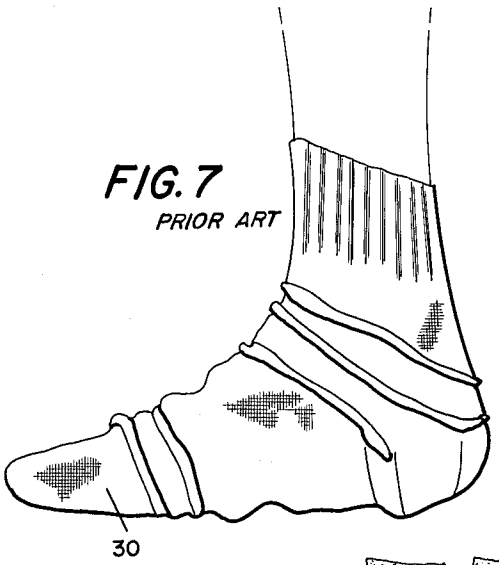

FIG. 7
PRIOR ART

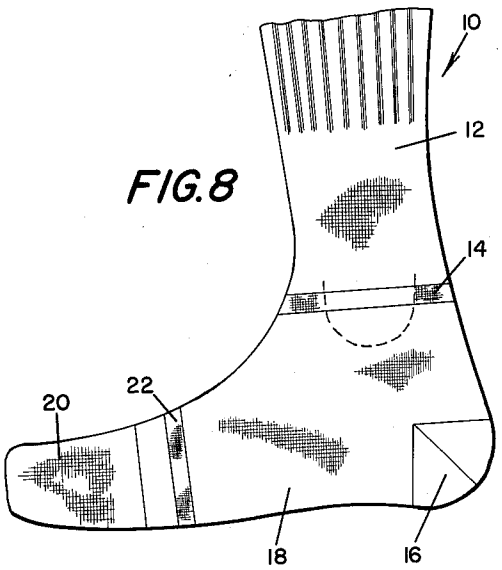

FIG. 8

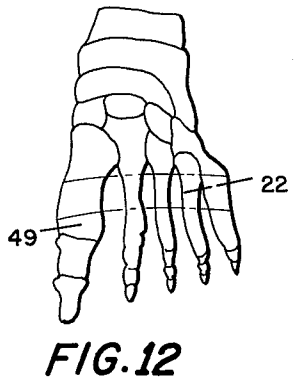

FIG. 12

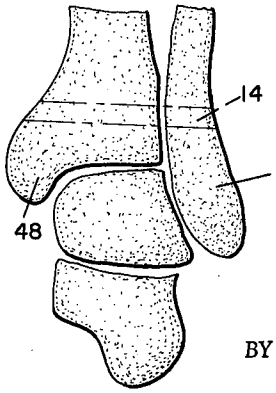

FIG. 9

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United States Patent Office

3,217,336
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KNITTED FOOTWEAR

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11 Claims. (Cl. 2—239)

The present invention relates to knitted footwear and more particularly to socks for preventing deformation of the feet.

Many types of socks having varying designs and constructions have been previously fabricated. However, inadequate attention has been paid to the socks' relation to the physiological and anatomical nature of feet and to the special nature of children's feet. The feet of young children are particularly susceptible to injury from pressures applied to the toes by poorly fitting socks; this is due to the fact that the bones of young children are cartilagenous and soft. The socks for children, just as for adults, now in use are generally tapered in the toe areas thereby causing the toes to become abnormally compressed. Pressure from such tapered toe portions in the socks and from the restrictions to the feet caused thereby are very undesirable and tend to injure and deform the wearer's feet. In addition, socks now generally in use tend to become disarranged on the foot which further exaggerates pressures on the toes, particularly among children who are not careful in maintaining their socks in proper position on their feet.

Toes are essential weight-bearing parts of the foot and commonly and properly, when required, spread outwardly during walking and standing. If the toes, when required, are not permitted to spread in the natural manner when walking and standing, poor posture and strains to the body result. Inadequate breadth in the forward part of the stocking at the toe portion causes the toes of the foot to squeeze together towards the center line running through the middle of the foot. Such toe distortions are, unfortunately, common for the most part, and become permanent in children due to their soft and cartilagenous bones. Such squeezing of the toes eventually affects posture. As an example, when toes are compressed and the person thus has a narrower forward base on which to stand, he has a tendency to seek compensation for decreased breadth through the toes by turning the feet inwardly or outwardly, thus producing either the fallen arch or pigeon-toed attitudes. Such unnatural foot postures eventually adversely influence the entire stature.

Moreover, the entire intrinsic musculature of the foot has to do with movement of the toes. If the toes are not permitted to move freely the muscles in the feet become weakened. Since these foot muscles also serve to bind down the 26 foot bones and the joints between the bones, weakness and distortion of the toes result from such socks and this also has a harmful influence on the entire foot, adversely affecting the mechanisms of the entire body. It is thus essential that toes have facility to spread at will if they are to remain functionally strong. The plexus of foot muscles that spread toes also help bind down the joints of the foot. Thus it is clear that socks presently in use, because of their shape and insufficient flexibility of toe fabric, inhibit toe spreading which cause poor feet, poor posture, and body instability.

Until the present time it has been usual to provide, in the conventional tapered sock, the same shape sock for both the left and the right foot. It is obvious, however, that the right and left feet are shaped differently with the great toes on opposite sides of the feet. It is thus clear that the usual sock which is tapered in the toe section compresses the great toes toward the center of the feet and is not suitable for either the left or right foot.

In addition, in the socks of the prior art, ankle portions of the sock tend to slip down from the ankle and gather around the heel of the foot. People, particularly children, who become very engrossed in their work and play may not notice such bunching of the socket material in the vicinity of the lower ankle and heel. Such bunching tends to loosen the desirable close fit of the sock at the heel and this later causes twisting of the loosened sock. Eventually, the heel part will slide downward towards the middle of the foot or the heel cup will lodge at the side of the heel and it is even common for the heel cup to shift up to the ankle due to the disarranged fabric. At any rate, whatever the distortion, the person is forced to walk on the twisted, wrinkled, distorted or bunched fabric rather than on the smooth sock. Because of the discomfort of the twisted fabric beneath the child's heel, the child is quite likely to walk differently, with misshaping pressures against his feet bones, thereby adversely affecting his entire posture.

Ribbing or elastic used in socks above the ankle has been conventionally used to attempt to prevent the socks from sliding and slipping down as above described. However, such ribbing or elastic does not give the desired results and does not prevent the ankle portions of the socks from slipping. In fact, such ribbing and elastic can encourage such slipping due to the simple fact that the calf, about which the ribbing or elastic grips, becomes thinner as it approaches the lower ankle and the gripping elastic part of the sock will slide down because it seeks a smaller circumference immediately above the ankle bones rather than the larger circumference about the lower calf.

It is also frequent, in conventional socks now available, for the forward portions of the sock adjacent the toes to slide rearwardly towards the heel. This is due to the fact that conventional socks are cylindrical in shape, having a uniform cross-section except at the toe area. Thus there is insufficient resistance in the tube-like insole and instep part of the sock to prevent that part of the sock from sliding rearwardly towards the heel. As the sock attempts to climb rearwardly towards the heel the toes of the individual are pinched and squeezed even more. Particularly in a child who walks or runs much, it is usual for his socks to "ride backwardly" and thus compress the toe portion of the sock tightly against the ends of his toes.

With no restraint at both the ankles and toes, socks often alternately move backwards and forwards with succeeding steps. These movements can either end with the heel part up at the ankle and the sock firmly pressed against the toes, or alternatively, with excessive sock material gathered and wrinkled together in the toe part of the shoe after having slid forward.

Most serious, in young children there is no pain when the toes are being deformed. Thus, even though a mother carefully dresses her child and checks the child's toe room when the socks are put on, such socks in a short while are generally twisted, wrinkled and bunched as above described due to the child's activity. Then the deforming pressures on the child's soft bones progress while the child is at play and the child and his mother can be utterly unaware of such deformation.

Thus, conventional socks result in harmful defects to the feet. Such conventional socks have unantomically shaped toes, have unphysiological inflexible toe-spreading capabilities, little room for the large toes of either the right or left foot, and the affinity to unrestrainably ride backwards against the toes and/or slide down towards and beneath the heel of the foot.

In recent years some of the above detrimental defects of socks have been exaggerated by the utilization of stretchable synthetic fibers. Such fibers are formed into socks wherein one size of stretch sock is used for several

sizes of feet. However, such socks, made in the usual way, provide even greater pressure than the conventional wool and cotton socks and, hence, the deforming character of the stretch socks, particularly with children, is even greater than with the conventional non-stretchable socks.

It is therefore an object of the present invention to provide novel socks which overcome the above disadvantages in the prior art.

It is another object of the present invention to provide socks and stockings for feet which do not provide deforming pressures against the great and smaller toes.

It is another object of the present invention to provide socks and stockings that do not encourage the formation of corns, ingrown toenails, callouses, fallen arches, and subsequent poor posture and body strains.

It is another object of the present invention to provide socks or stockings which do not bind the feet and which encourage muscular toe exercise while the sock is being worn to ultimately provide greater foot strength.

It is another object of the present invention to provide left and right socks having identifying marks so that the left and right socks may be easily identified.

It is another object of the present invention to provide socks which will neither slide down toward the heel of the foot nor which will ride backwardly on the toes.

It is another object of the present invention to provide children's socks which fit more securely and better so that the socks maintain their positions on the feet and do not cause the cartilaginous bones in the feet to become misshapen.

Other objects and the nature and advantages of the instant invention will be apparent from the following description taken in conjunction with the accompanying drawings, wherein:

FIG. 1A is a top view of a flattened sock in accordwith the present invention;

FIG. 1B is a top view of another embodiment of a flattened sock in accordance with the present invention;

FIG. 1C is a top view of a mate of the sock in FIG. 1B;

FIG. 2 is a top view of a conventional sock superimposed on a foot;

FIG. 3 is a top view showing one feature of the present invention;

FIG. 4 is a side view of another embodiment in accordance with the present invention;

FIG. 5 is a detail characterization of the weave of a sock in accordance with the present invention;

FIG. 6 is a side view of a conventional sock on a foot;

FIG. 7 is a side view of a conventional sock on a foot after some wear;

FIG. 8 is a side view of a sock in accordance with the present invention, on a foot;

FIG. 9 is a schematic diagram showing one feature of the present invention;

FIG. 10 is a side view showing a conventional sock;

FIG. 11 is a top view showing a foot in a conventional sock;

FIG. 12 is a schematic diagram showing another feature of the present invention; and

FIG. 13 is a side view of a foot and a partially broken away sock in accordance with the present invention.

A sock in accordance with the present invention is shown generally in FIG. 8 at **10** and comprises a top portion **12** which, during wear, fits about the lower calf portion of the leg. Immediately below the upper portion **12** and at a point corresponding to the malleolei of the foot is provided a tension band **14**. Beneath the tension band **14**, a conventional heel portion **16** of a sock is provided. Disposed in front of the heel portion **16**, as is conventional in socks, is a foot or sole and instep portion **18** and at the forward end of the sock is a toe portion **20**. Between the toe portion **20** and the instep-sole portion **18** is a second tension band **22**.

The tension bands **14** and **22** may be formed of the same or different weight yarns from which the remaining sock is formed, e.g., cotton, wool, etc. If such is the case the tension bands must be formed of a tighter and smaller knit such as is shown in detail in FIG. 5. Alternatively, the tension bands may be formed of elastic materials such as stretchable synthetic yarns, rubber, etc., as shown at **14'** and **22'** in FIG. 4.

In the embodiment of FIG. 1A the toe portion **20** is provided in a generally rectangular shape so that the toes of the child wearing the sock will not be restricted and further, so that either sock may be worn on either foot without squeezing the toes. In the embodiments of FIGS. 1B and 1C, on the other hand, a left and a right foot sock are provided as a pair and such socks have a tapered toe portion to correspond to the shape of the toe portions of the left and the right foot. FIG. 1B and FIG. 3 show a sock for the right foot while FIG. 1C shows a sock for the left foot.

A critical feature of the present invention resides in the weave of the toe portion **20** of the sock **10**. As shown in detail in FIG. 5, it is seen that the weave in the toe portion **20** is wider and looser than the conventional weave in the sock such as is present in the sole-instep portion **18**. Such a loose weave is very easily stretched and permits the toes to spread and expand easily, and with facility.

FIG. 2 shows the relationship between a foot in the unrestrained position and a conventional sock. The conventional sock **30** has a tapered toe portion wherein the normal width of the sock *b–b'* is approximately twice the width of the toe portion of the sock *a–a'*. Superimposed in phantom over the outline of the conventional sock **30** is a human forefoot in its normal shape. Thus it is seen that there is insufficient room for the big toe and the little toe within the toe portion **30** of the sock. Thus when the foot is placed within the sock, such as is shown in FIG. 11, the toe portion **31** of the conventional sock **30** tends to constrict and pinch the toes to conform essentially to the dimension of the toe portion *a–a'*. Although there is insufficient and constricted space for the 1st and 5th toes in the conventional sock **30**, there is, immediately in front of the middle toes of the foot an excess space **32**. Thus, it is clear that such a conventional sock **30** does not sufficiently correspond to the physiological needs and anatomical shape of the human forefoot.

FIG. 3, on the other hand, shows a view of the foot and the toe portion of a sock **10** in accordance with the present invention which shows how the sock is shaped to fit the shape of the human foot. It is seen that the width of the toe portion of the sock can be expanded with facility to accommodate the spreading of the toe ends.

Since conventional socks **30** have a tapered toe portion **31**, as shown in FIG. 2, a shape such as provided in the sock **10** of the present invention is a clear improvement for the positioning of the toes within the sock. The provision of such a shape in accordance with FIG. 1A can be accomplished with conventional knitting machinery. This is accomplished by arranging the needles for the toe portion of the sock so that the usual picking, dropping and reciprocating knitting which conventionally forms the toe portion are eliminated. Thus the toe portion of the sock is then knitted in an open uniform tube. A looper line can be added to give the operator a gauge by which to measure so that the end of the sock may be either cut by hand and then seamed together or placed in a clamp for cutting and seaming with a machine. If (in FIG. 1A) a looped or seamed closing is desired on top of the sock, needles are arranged so the terminal toe portions of fabric are suitably knitted.

Alternatively, the shape of the toe part of the sock in FIGS. 1B and 1C can be provided by the use of a combination of picking and dropping needles together with reciprocating knitting processes so that the fabric is formed to a close approximation of the shape of the

end of the toe. With boarding, therefore, no unusual artificial stretching of the original fabric is necessary to secure the shape of the toe portion of the sock in FIGS. 1B, 1C and 3. The end of the toe portion may then be closed in any suitable manner, e.g., looping or seaming. Also, the seam may be formed at the extreme toe portion **36** or at the top of the sock as at **36'**.

One of the most critical features of the present invention is the more flexible knit fabric in the toe portion **20** of the sock. As noted in FIG. 11 a conventional sock **30** inhibits the spreading of the toes as pressure is exerted on the toes. Because of the narrow confines and the conventional tight weave of the socks in the toe portion of conventional socks, it is extremely difficult for the fabric to stretch to approximate the variations of spreading shapes required by the toes during walking or standing. In FIG. 3, on the other hand, dotted line **38** shows how the toes are permitted to spread during walking or standing. Because of the more flexible fabric in the toe portion **20** of the sock **10**, such sock does not restrain the spreading of the toes but easily stretches, as shown by dotted lines **40**, to accommodate the spreading toes. The elasticity of the toe portion **20** of the sock **10** is provided by arranging the needles of the knitting machine so that there is less densely knitted fabric in the toe portion. As shown in FIG. 4 the loose weave toe portion **20** accounts for approximately one-fifth of the length of the socks from the back of the heel portion **16** to the front of the toe portion **20**. Such a distance, one-fifth of the sole length of the sock, is necessary so that the toes are free to spread along their entire length.

In order to compensate for wear in the toe portion due to the loose knit, it may be found practical to knit the toe portion from a heavier weight yarn or a more wear resistant yarn. However, when using a different type of yarn in the toe portion, care must be taken that no severely contracting types of yarns are used in contrast. For smaller children and infants, on the other hand, a different yarn need not be necessarily used in the loosely knitted toe portion **20**, because younger children and infants generally do not walk and those that do most usually outgrow socks long before they outwear them. Thus, resistance to wear of the toe portion **20** of the socks is not a practical consideration for the socks of infants.

When providing socks such as shown in FIGS. 1B and 1C, i.e., left and right socks, it is desirable to provide a distinguishing mark **42**, preferably adjacent the big toe area, so as to quickly tell which sock should go on which foot. Such a distinguishing mark **42** may be in the form of a dot which may be colored or it may be any other desirable symbol. Such a mark may be knitted into the fabric or, alternatively, may be imprinted thereon. As indicated above, the left and right footed socks are in alternative to the rectangularly shaped toe portion such as shown in FIG. 1A, either embodiment providing the necessary unrestricted toe room desirable in the present invention.

FIG. 6 is a view of a foot which shows a conventional sock **30** fit over a foot and an ankle. FIG. 10 is a view of the same sock **30** off the foot. Comparing these figures, it is seen in FIG. 10, that the distance from *e* to *f*, the width of the flattened sock above the heel and below the ankle and *e'* to *f'*, the width of the flattened sock above the ankle, is the same, the ankle part of the conventional sock **30** being knitted in a tubular form with the same measurements and texture of knitting throughout the entire area from the heel **34** to the top **37**. Noting FIG. 6, however, it is seen that the ankle itself is not the shape of the uniform tubular configuration of sock **30**. Thus, in FIG. 6 the sock must be stretched to conform to the dimension *e–f* on the foot which is considerably larger than the dimension *e'–f'*. Not only is the ankle thinner above the ankle bone **44** but there is a protrusion at the malleolei as shown in FIG. 9 and there is a broadening of the ankle below the malleolei as seen by the dimension *f* to *e* in FIG. 6. It is thus clear that the cylindrical tubing of the ankle part of the conventional sock **30** shown in FIG. 10 would tend to drop down on the wider lower part of the ankle and over the malleoleus so that the conventional sock **30** would droop or fall down to the lower ankle and even to the heel and foot part of the sock, such as shown in FIG. 7. As previously indicated this occurs frequently and especially with active children and for the reasons stated such drooping is desirable to overcome.

The above drooping and falling of the sock such as shown in FIG. 7 is overcome by providing a tension band **14** such as shown in FIGS. 8 and 9. FIG. 9 shows a vertical cross-section of the bones of the ankle. The foot is provided with two protrusions **46** and **48**, commonly known as the malleolei or ankle bones. Protrusion **46** consists of the outer malleoleus on the lower fibia while protrusion **48** consists of the iner malleoleus on the lower part of the tibia. It is apparent that the malleolei **46** and **48** act as a partial deterrent to the anatomical and gravitational inclinations of the ankle part of the sock to droop. Thus, if the tension band **14** is provided immediately above the inner and outer malleolei **46** and **48**, such a tension band greatly inhibits the ability of the sock to droop or fall towards the heel. As previously mentioned, the tension band **14** may consist of closely knitted yarn similar to tension band **22** in FIG. 5 or, alternatively, may comprise elastic such as shown at **14'** in FIG. 4. The tension band **14** is placed just above the most protruding parts of the malleolei **46** and **48**, such as shown in FIG. 9.

The tension band is preferably from 3/16 to ½ inch in width and will vary according to the size of the socks. It can be formed of the same yarn as used to form the remainder of the sock with the band of denser fabric knitted in shorter stitches or comprised of a different yarn knitted in shorter stitches. Socks with these tension bands may be knitted in a manner easily adjusted for on the usual circular knitting machine or by hand knitting. Care must be taken that the tension band **14** is not too tight so that it is difficult to put the sock on. Also, the tension bands can be knitted so as not to look too different from the adjacent fabric. These tension bands may be used on jersey type fabric or as a combination with ribbed or elastic type fabrics and will inhibit ankle drooping in such fabrics more effectively since repeated washings often make ribbing and elastic less resilient and by themselves progressively ineffective to provide a good ankle fit.

Elastic and ribbed weaving in conventional socks commonly does not extend down as far as the area immediately above the malleolei and there is thus provided an excess of fabric looseness at that critical area than is required for good sock stability. Also tighter elastic and tighter ribbed constructions conventionally utilized at the top of the sock to attempt to keep the sock from falling down presses against soft flesh of the ankle and lower calf and harmfully limits circulation to the feet. Thus, ribbing and elastic conventionally used in the lower calf area when it is effectively firm, compresses extensive areas of that flesh with limitations to the circulation. Such ribbing or elastic would be intoleable for infants in general and also for adults with poor circulation. A tension band **14** in accordance with the present invention, on the other hand, will not firmly constrict except when drawn over the protruding malleolei. These malleolei are subcutaneous bones and pressure against such bones will not limit circulation.

Once again, noting the conventional sock **30** of FIG. 10, it is seen that the circumference in the sole and instep area between the toe and heel is of cylindrical construction and in the flattened sock the distance between *k* and *k'* and between *j* and *j'* is the same. However, as clearly seen in FIG. 6 after the sock is put on the foot, there is a marked difference in the distances between *k–k'* and *j–j'*. It is clear that the dimension *j–j'* on the foot is much less than the dimension at *k–k'*. When a shoe is worn over the sock and the foot plungers forward in the shoe with each step, the tendency is for the toe part of the

sock 20' to ride backwards towards the heel. In effect, this causes the toe portion 20' to crowd backwards against the toes, causing them to be cramped together as shown at the toe portion of the sock in FIG. 7.

To alleviate this commonplace difficult, a tension band 22 is formed around the metatarsal bones behind the point 49 corresponding to the joints of the toe bones and the metatarsal bones, as shown in FIG. 12. The tension band 22 may be knitted with the same yarn with shorter stitches or a different yarn with shorter stitches and should extend in width from 3/16 to 1/2", depending upon the size of the sock.

In FIG. 13 the juncture of the toe bones and the metatarsal bones is indicated at W. The top part of the foot, or instep, rises from the junction of the toe bones and the metatarsal bones and causes the foot to have increased depth so that at the point W' the foot becomes thicker than at point W. Therefore, a tension band fit as shown in FIG. 13, behind the ball of the foot around the metatarsal bones and behind the metatarsal bones juncture with the toe bones, would prevent the toe portion of the sock from riding backwards towards W'. Thus tension band 22 would tend to stabilize the sock on the toe section of the foot and prevent the sock from sliding backwards towards the heel to jam the toes of the foot.

Care must be taken to ensure that the instep band 22 is not too far forward towards the toe portion 20 of the sock, since if it is moved too far forwardly it will interfere with the flexibility of the loosely knitted fabric 20 in the toe portion which is necessary for spreading of the toes. It is also necessary that the tension instep band 22 not be too far back towards the heel portion or it will not properly inhibit the sock from riding back towards the heel portion, particularly in the case where a loosely knitted toe portion 20 is provided, since such loosely knitted toe portion will normally permit a greater degree of riding back than is normally conventional.

It will be obvious to those skilled in the art that various changes may be made without departing from the spirit of the invention and therefore the invention is not limited to what is shown in the drawings and described in the specification, but only as indicated in the appended claims.

What is claimed is:

1. A sock comprising an open top portion adapted to receive a foot, an ankle portion below said top portion having a first tension band therearound adapted to rest immediately above the malleolei of the foot for inhibiting falling of the sock toward the heel of the foot, a heel portion below said ankle portion, a sole and instep portion disposed beside said heel portion having a second tension band therearound adapted to rest at a point immediately rearwardly of the joints of the toe bones and the metatarsal bones for inhibiting backward sliding of the sock toward the heel of the foot, and a closed toe portion, said sock having a standard knit along the majority of its length and a loose knit from the tip of the closed toe portion to about 1/5 of the distance to the end of said heel portion for permitting unrestrained expansion of the toes.

2. A sock in accordance with claim 1 wherein said closed toe portion has a normal width substantially equal to the width of the entire sock and is symmetrical about the central axis.

3. A sock in accordance with claim 1 wherein said closed toe portion is adapted to lie straight against the sides of the toes and is tapered to correspond to the general shape of the toe portion of a foot wherein said sock is longer on one side of its central axis than on the other side.

4. A sock in accordance with claim 3 wherein said toe portion on the longer side of said sock is provided with an indicium to assist in determining if the sock is for the left or right foot.

5. A sock in accordance with claim 1 wherein said tension bands are formed of non-compressive elastic material.

6. A sock in accordance with claim 1 wherein said tension bands are formed of more tightly knitted fabric than the remainder of the sock.

7. A sock comprising an open top portion adapted to receive a foot, an ankle portion below said top portion having a first tension band therearound adapted to rest immediately above the point corresponding to the malleolei of the foot for inhibiting falling the sock toward the heel of the foot, a heel portion below said ankle portion, a sole and instep portion disposed beside said heel portion having a second tension band therearound adapted to rest at a point immediately above the point corresponding to the junction of the toe bones and the metatarsal bones for inhibiting backward sliding of the sock toward the heel of the foot, and a closed toe portion.

8. A sock in accordance with claim 7 wherein said tension bands are formed of elastic material.

9. A sock in accordance with claim 7 wherein said tension bands are formed of non-compressive but more tightly knitted fabric than the remainder of the sock.

10. A sock in accordance with claim 7 wherein said tension bands are from 3/16 to 1/2 inch in width.

11. A sock comprising an open top portion adapted to receive a foot, an ankle portion below said top portion, a heel portion below said ankle portion, a sole and instep portion disposed beside said heel portion having a tension band therearound adapted to rest at a point immediately rearwardly of the joints of the toe bones and the metatarsal bones for inhibiting backward sliding of the sock toward the heel of the foot, and a closed toe portion, said sock having a standard knit along the majority of its length and a loose knit from the tip of the closed toe portion to about 1/5 of the distance to the end of said heel portion for permitting unrestrained expansion of the toes.

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