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METHOD OF KNITTING TUBULAR ARTICLES

Filed March 22, 1967

2 Sheets-Sheet 1

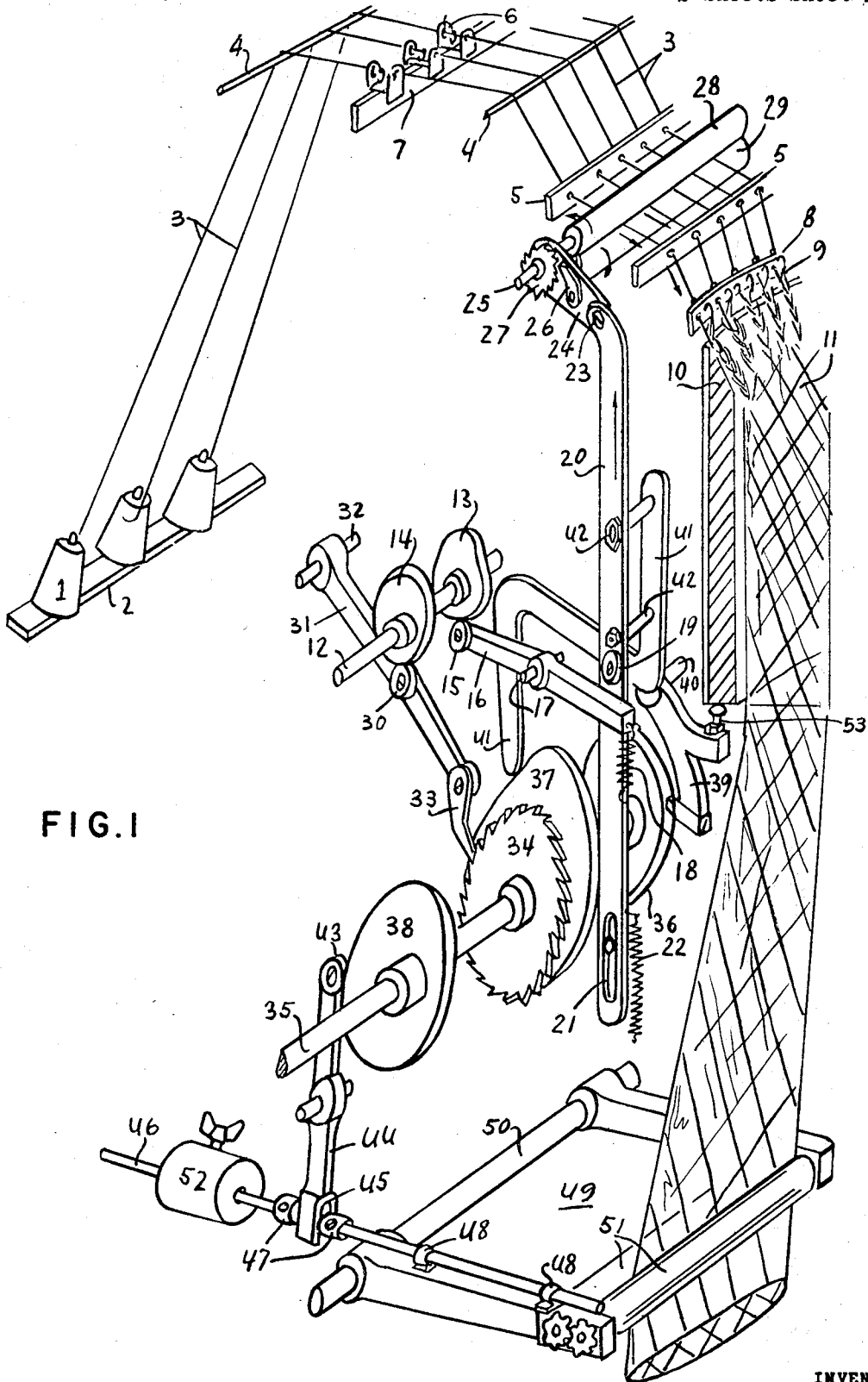


FIG. 1

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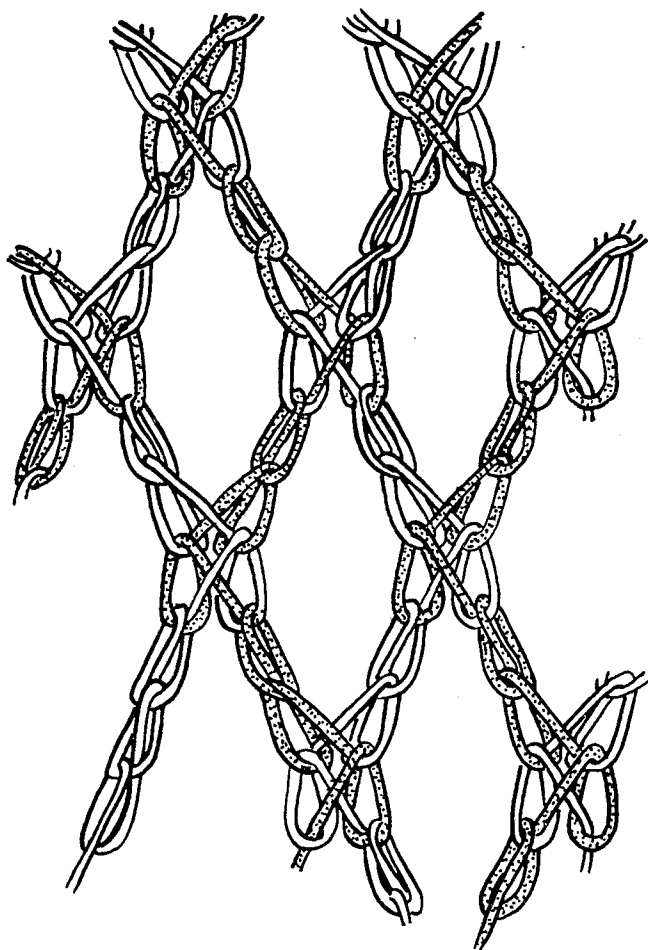


FIG. 2

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2 Claims

ABSTRACT OF THE DISCLOSURE

A method of manufacturing fabric articles of tubular configuration by warp knitting with a row of needles and a coating row of loopers while feeding to each needle and looper yarn from a creel under conditions of controlled tension. The loopers and needles are actuated so that at least part of the yarns which form chains of loops or which are tied thereby are periodically displaced first to one side and then to the other side of a reference needle through a given number of positions or past a given number of needles, this number being variable, and the operating conditions under which the warp knitting is carried out are changed during loop formation so as to produce a variation in the transverse dimensions of the tubular article. The row of needles is circular, and the yarn is fed from the creel to the needles and loopers at a variable feed tension in accordance with a predetermined program so as to produce variations in the diameter of the tubular article along the length thereof. The transverse dimensions of the tubular article may be controlled by correspondingly regulating the length of yarn which is fed to the knitting elements and taken up thereby during loop formation. Also, the extent of displacement of the loops is varied during loop formation, and in addition the tension with which the knitted tubular article is withdrawn from the machine is varied, so that by utilizing any one or a combination of these expedients, it is possible to control the transverse dimensions of the article providing the latter with a variable diameter along the length thereof.

BACKGROUND OF THE INVENTION

The present invention relates to a method of manufacturing a fabric article of tubular configuration.

For example, the invention may be used for the manufacture of articles of clothing, such as stockings, socks, leotards, or the invention may be used for the manufacture of parts of garments, such as sleeves, body portions of garments, leg portions thereof, and the like.

In particular, the present invention relates to the knitting of seamless tubular articles.

At the present time, the production of tubular fabric articles involves sewing, which is of course highly undesirable. This consideration applies particularly to knitted articles of high quality which are required to be fashioned so as to have a variable cross section in the final article. Articles of this latter type necessarily include a visible heavy seam used to join together the edges of the flat-knitted fabric sections in order to produce the tubular form of high quality knitted articles which are fashioned.

SUMMARY OF THE INVENTION

It is, therefore, a primary object of the present invention to provide a method of manufacturing a seamless knitted tubular article of high quality having a variable transverse dimension and provided with a knitted loop structure which cannot be achieved with presently known methods for manufacturing tubular knit wear.

Thus, it is an object of the present invention to provide a fashioned but seamless tubular knitted article re-

quiring absolutely no sewing of any kind, whereas up to the present time such sewing was essential to provide the tubular fashioned article and proved to be of a predominantly poor aesthetic effect.

Thus, it is an object of the present invention to provide a method for manufacturing a knitted tubular article of variable diameter along its length and capable of being used for articles such as stockings or for parts of garments such as sleeves thereof, in apparel of high quality with a knitted mesh which has no visible seam.

It is a further object of the invention to provide a circular knitting machine having a means for gradually varying the elevation of a needle cylinder so as to control the length of the loops or stitches formed at the top ledge of the needle cylinder during downward movement of the knitting needles with respect to this top ledge.

According to the method of the invention the tubular article is knitted with warp knitting operations utilizing a row of needles and at least one substantially coextensive row of loopers, while feeding at a controlled tension yarn to each needle and looper from a creel. The loopers and needles are actuated during loop formation while chains of loops are knitted in such a way that at least part of the yarns which form the chains of loops or yarn tied thereby is periodically displaced first to one side and then to the other side of a reference needle through a distance corresponding to a number of positions or needles which may be variable. At the same time the operating conditions under which the warp knitting is carried out are changed during loop formation so as to produce a variation in the transverse dimensions of the tubular knitted article.

The invention is illustrated by way of example in the accompanying drawings which form part of this application and in which:

FIG. 1 is a fragmentary, schematic, perspective illustration of one possible structure which carries out the method of the invention; and

FIG. 2 is a fragmentary perspective illustration of part of a fabric knitted according to the method of the invention.

With the circular knitting machine of the invention a cam and a cam-follower means coact with each other and with the needle cylinder for gradually changing the elevation of the latter in a cyclical, predetermined manner during the knitting operations to vary the elevation of the top ledge of the needle cylinder and thus vary the extent through which the loops or stitches are drawn by the hooks at the top ends of the needles, so as to control in this way the lengths of the loops.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

In accordance with the method of the invention a circular type of knitting machine may be used, this machine being provided with a circular row of knitting needles capable of being operated to form chains of loops. One or more circular rows of loopers coact with the circular row of needles and are capable of being actuated so that the operating ends of the loopers are respectively displaced radially between the circular row of needles which extend vertically, and in addition the circular row or rows of loopers can be angularly displaced with respect to the circular row of needles before being radially displaced through the spaces between the latter, so that at one radial displacement of the loopers they will pass through the spaces between predetermined needles while during another radial displacement of the loopers, after they have been angularly repositioned with respect to the circular

row of needles, they will pass through different spaces, respectively, between the vertical row of circularly arranged needles.

One or more yarns are fed at a predetermined tension, according to the article or part of an article which is to be manufactured, to the needles of the circular row from a multiple creel which is provided with the number of yarn feed spools required for the number of needles which are to be fed with yarn.

In the same way, each looper of a given row is threaded with one or more of the threads or yarns which are fed under conditions of controlled tension from the supply spools at the creel.

The diameter of the circular row along which the needles are arranged and of the series of circularly arranged loopers associated therewith varies, naturally, with the diameter of the tubular article which is to be manufactured. In like manner, the tension with which the yarns are fed is adjusted in accordance with the results which are to be achieved, and the values of these tensions at all or parts of the yarns can be regulated and varied in a controlled manner for the purpose of providing variations in the diameter of the tubular article which is knitted. For example, these operations may be used to provide a preliminary predetermined configuration in the knitted tubular articles which may, for example, be subsequently used in the manufacture of stockings and similar or equivalent articles.

For the purpose of increasing the possibilities for varying the transverse dimensions of the tubular articles knitted according to the invention, this variation in the transverse dimensions being achieved, as pointed out above, by varying the feed tension of the yarns which form the chains of loops, the warp knitting is carried out so as to influence other variables to achieve certain advantages in particular cases of specific use of the method of the invention.

For this purpose, and in accordance with an additional feature of the invention, the fabric is knitted so that the loops thereof may be stretched to a greater or lesser extent. When the fabric is withdrawn from the machine in a loose or relaxed state, the variable lengths of yarn which form various loops thereof enable the tubular knitted article to have a greater or lesser extent of transverse extension, with much the same results as those achieved by the expedients referred to above. The manner of acting directly upon the amount of yarn used for loop formation during knitting of the article is brought about, in accordance with the invention, by providing corresponding variations in the extent of the displacements of the loops by the needles while the latter form the loops, and this control can be derived from automatic control mechanism of the machine according to a predetermined program of operations.

It is also possible, in accordance with the invention, to achieve the same results by regulating the tension with which the knitted fabric is withdrawn from the machine, and of course, it is to be understood that this particular expedient can be used in any desired combination with the above expedients.

It is to be understood that the conditions of controlled tension are such that all of the yarns can be tensioned with a uniform tensioning force, or the yarns fed to the needles and those fed to corresponding loopers can respectively have different tensions, without, however, excluding the possibility of varying each of these tensions in its entirety or during knitting of preselected portions of the tubular article so as to provide predetermined variations in the transverse dimensions of the tubular articles which are knitted, so that in this way the tubular knitted articles of the invention are provided with variations in width required by the particular garment which is knitted or required in order to provide the tubular article with a preliminary configuration to be acted upon by a subsequent molding operation in the event that the knitting is carried out with thermoplastic yarns.

The yarns which are fed may be of any suitable nature depending, in general, on the type of article which is to be knitted and on the characteristics which are required in the knitted article in anticipation of particular uses to be made thereof. Thus, for example, it is possible to use with the method of the invention yarns made of natural fibers, such as cotton, wool, flax and silk; yarns made of synthetic fibers, such as rayon, viscose and acetate, both in the form of polyfilaments and as single staple fibers or in combination with natural fibers; or yarns in the form of synthetic filaments, for example vinyls, polyamides, polyesters, or polyurethanes, in their normal condition or in a condition subsequent to treatment thereof in order to achieve modifications which accentuate certain properties such as, for example, their elastic properties or properties achieved by way of false twisting. When the yarns take the form of monofilaments or polyfilaments they may be combined together or with any of the natural or synthetic materials referred to above.

During operation of the knitting machine the needles and loopers are operated to carry out warp-knitting operations, forming individual chains of loops, and the yarns which form part of these chains and other yarns which are tied thereby are displaced to the right and left of a given needle past a predetermined number of needles or positions which may be varied according to the type of knitted mesh or open-work design which it is desired to achieve in the knitted article.

The movements of the loops can be regulated according to the properties of the fabric which is to be knitted, and also in this case there is the opportunity of utilizing another feature of the invention, namely varying the magnitude of displacement of the needle cylinder during the loop formation so that in this way it becomes possible to vary the transverse dimensions of the tubular knitted fabric and thus the configuration of the final knitted article. A similar result can be achieved by varying the tension with which the knitted fabric is gathered or taken from the machine.

The tubular articles which are provided in this way can then be cut into predetermined lengths in accordance with the subsequent manipulations to which they are to be subjected. In the case of manufacturing stockings, for example, the upper end of each stocking may be finished as by adding thereto a preformed welt, this welt being obtained separately from the knitted article and being attached thereto as by being sewn thereto. However, the welt may be provided by folding over the upper edge of the stocking. The upper edge portion of the stocking which is thus folded over is of course sewn to the remainder of the stocking at the upper region thereof so as to provide the required welt. It is also possible to knit as the last course of the article an elastic protective course, or a narrow elastic band may be attached to the end of the stocking. Variations of this latter type are particularly suitable for the manufacture of stockings intended to be used with apparel which includes short skirts, inasmuch as the upper edge of such a stocking is relatively small and thus less visible.

The lower ends of tubular articles intended to be used in the manufacture of stockings may be closed in a conventional manner, by means of machines conventionally used for this purpose.

The stockings which are achieved with the method of the invention may be subjected to conventional finishing and dyeing treatments, and particularly when the articles are made with thermoplastic yarns, as is true of the vast majority of synthetic yarns, they may be premolded in a conventional manner so as to provide them by suitably shaping the heel with the final configuration which is required when the article is purchased by the ultimate consumer.

It is apparent that the above-described method of the invention, utilizing warp knitting of the Raschel or

Ketten type, provides a considerable advance inasmuch as up to the present time it has not been possible to achieve tubular articles such as stockings and sleeves which are knitted while being fashioned and having no seam with this type of knitwear. Up to the present time there has been no knitted tubular articles such as stockings or garment parts such as sleeves capable of being used in high quality apparel and having a mesh or open-work knit structure which did not also have a heavy seam which is more or less visible and which was essential to provide the tubular configuration of the article by sewing together the side edges of flat knitted pieces for garments and the like of relatively high quality. Thus, with the method of the invention there is no visible seam so that the poor effect on the appearance of the article which necessarily results from such a seam is eliminated and at the same time all of the work and problems resulting from such a seam are also eliminated.

Referring to the drawings, FIG. 1 shows an example of how the knitting may be performed with a machine of the Raschel or Ketten type.

The yarn is derived from yarn bobbins 1, located at a creel 2, and, as indicated at 3, the yarns are guided by rods 4 and apertured bar 5, as well as yarn tensioners 6, carried by a bar 7, to the looper bar 8 coacting with needles 9 in a needle plate 10 to form the knitted tube 11. Only one looper bar 8 is shown, for the sake of clarity, but it is clear that a similar arrangement may be used for any additional looper bars required. On the other hand, it is to be noted that the above structure operates in a conventional manner.

The remaining elements shown in FIG. 1 are primarily concerned with one example of a means for continuously changing the tension of the yarn in order to achieve the variable mesh of the knitted fabric.

A shaft 12 is rotated continuously by the mechanism of the machine and has a cam 13 and an eccentric 14.

The cam 13 engages a cam follower roller 15 mounted on one end of the rocker arm 16 pivoted at 17 and biased by the tension spring 18 at the opposite end thereof. A roller 19 is adapted to rest on the biased end of the rocker 16 and is mounted on a vertically extending bar 20 which may be vertically reciprocated and guided by slide devices such as 21 and is biased downwardly by the tension spring 22. The upper end of the bar 20 is articulated at 23 by an oscillating arm 24 turnable on a shaft 25 and carrying a pawl 26 which engages a ratchet wheel 27, fixed with the shaft 25. The shaft 25 carries an upper roller 28 which forms a nip with a lower roller 29, the rollers being driven according to the arrows in order to positively feed the yarns 3 to the knitting station.

The eccentric 14 engages a follower roller 30 carried by an arm 31 oscillating about the shaft 32 and carrying a free ratchet pawl 33 which constantly meshes with the ratchet wheel 34 fixed with the shaft 35. The shaft 35 has, furthermore, fast thereon three cams 36, 37 and 38 that are, hence, intermittently racked at each turn of the eccentric 14.

Cam 36 is engaged by a cam follower 39 rocking on a shaft 40 and serves to change the vertical position of the needle plate 10.

Cam 37 is engaged by a cam follower 41 which is secured by means of bolts 42 to the vertically reciprocating rod 20. The profile of this cam is so selected that it may allow the roller 19 to continuously rest on the rocker 16 so that the bar 20 and the associated feed mechanism 23-29 is racked according to the full swing of cam 13, or it may progressively raise the roller 19 so that a variable dead or idler motion takes place before the said roller 19 is moved upwardly by the rocker 16. Thus, the rising portions of the cam 37 have the effect of reducing the stroke of rod 20 and the rack of the positive feed mechanism.

Cam 38 operates, through a cam follower 43, a rocker arm 44 having a fork-shaped end 45 which engages the rod 46 by means of two fixed collars 47. The rod 46 is slidable in two sleeves 48 secured to conventional tensioning device 49, oscillating about the shaft 50 and carrying the nip rollers 51 which are in turn driven by a conventional, not shown, drawing mechanism to pull the knitted article 11 downwardly. An adjustable balance weight 52 provides for variations of such downward pull.

It is seen that a shorter rack of the feeder device 23-29 will furnish less yarn to the knitting station thereby producing smaller loops or mesh; a greater stroke feeds more yarn and gives a looser knit.

The pattern of cams 36, 38 will, of course, be selected according to the knitting variation which it is desired to obtain along the hose.

A showing of the knitted fabric is given in FIG. 2, wherein the yarns of two different looper bars are distinctly shown. Although the narrow field used does not allow a clear distinction of the size of the loops to be appreciated, this feature can easily be imagined.

As is apparent from FIG. 1, the cam-follower 39 which coacts with the cam 36 carries a stop 53 so that during swinging of the cam-follower 39 the elevation of the needle cylinder 10 will be regulated. The needles 9 are reciprocated vertically in a well-known manner through a given stroke so that the gradual change in the elevation of the needle cylinder 10 through the cam 36 and cam-follower 39, which form a cam and cam-follower means for regulating the elevation of the needle cylinder 10, brings about a change in the elevation of the top ledge of the needle cylinder 10 with respect to the top hook ends of the needles 9 so that the extent to which the loops or stitches are drawn downwardly beyond the top ledge of the cylinder 10 be regulated in this way. The result is that the length of the loops or stitches may be continuously varied in this way also to bring about a given predetermined fashioning in a cyclical manner determined by the configuration of the cam 36.

It is also to be noted that with the method of the invention the several different possibilities of controlling the fashioning not only can be used in any desired combination, but in addition, any one control can be regulated without influencing the other controls. Thus, the yarn feed by the rollers 28 and 29 can be regulated independently of the particular elevation of the cylinder 10, and both of these latter controls can be effected not only independently of each other but independently of the rate of withdrawal of the yarn from the machine by the structure shown at the lower part of FIG. 1. Therefore, when one control is adjusted, the other controls remain unchanged, making it possible to bring about the desired regulations in an exceedingly convenient and precise manner.

What is claimed is:

1. In a method of manufacturing a textile article of tubular configuration, the steps of warp knitting a series of individual chains of loops with knitting needles arranged in a circular row and at least one circular row of loopers coacting with the circular row of needles while feeding to each needle and looper yarn from a creel under a controlled tension, actuating said loopers and needles to periodically displace at least part of the yarns which form the chains of loops or yarn which are tied thereby first to one side and then to an opposite side of a reference needle through a variable number of positions or needles, and continuously modifying the operating conditions during loop formation in a manner providing a gradual change in the transverse dimensions of the tubular article which is knitted including the steps of automatically and progressively varying the width of the knitted fabric by simultaneously modifying the extent of vertical displacement of the loops by needles during loop formation, varying the length of the yarn fed to the needles and loopers, and also varying simultaneously the

tension with which the knitted fabric is withdrawn from the machine.

2. In a method as recited in claim 1, wherein said the steps of modifying the extent of vertical displacement of the loops, varying the length of yarn fed, and varying the tension of fabric withdrawal are carried out entirely independently of each other.

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