

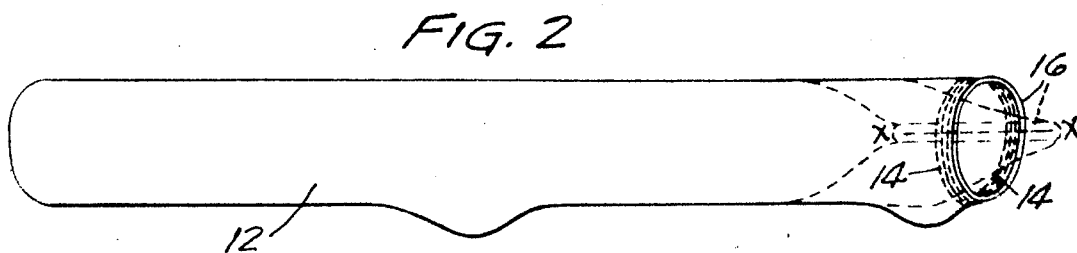
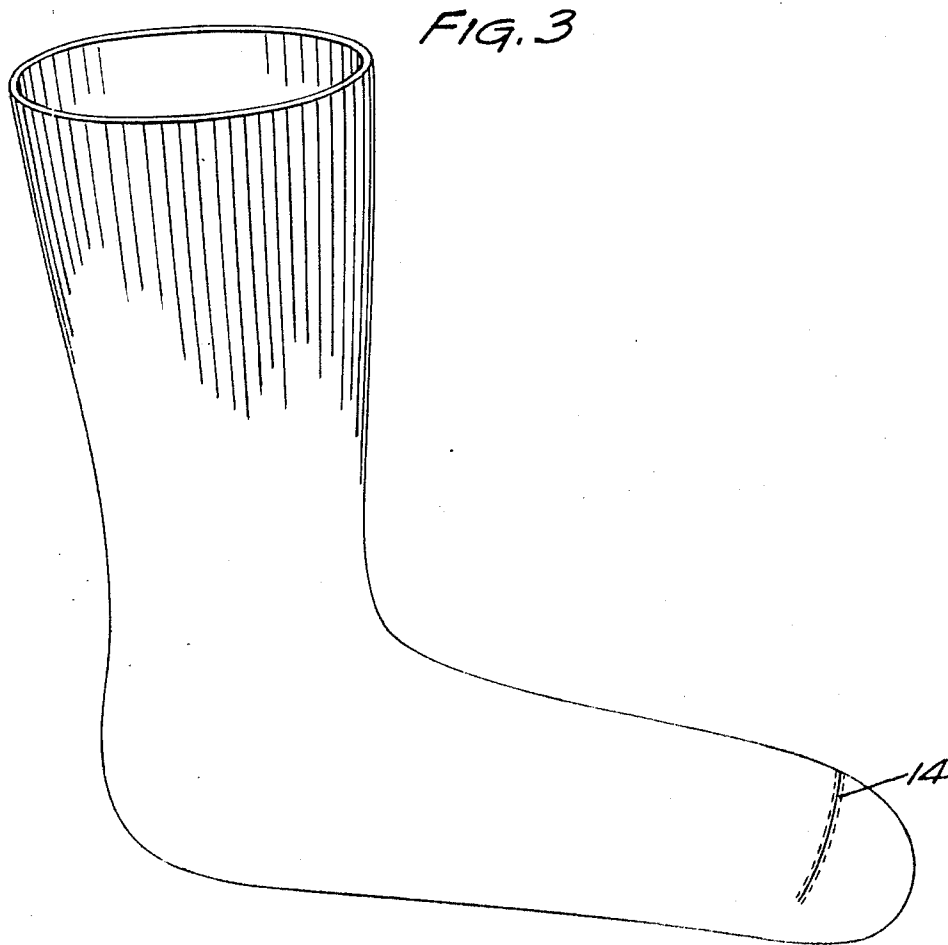
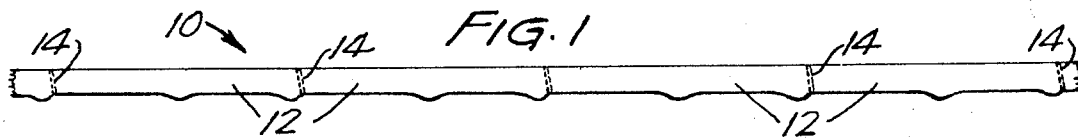
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BONDING OF FABRIC WITH ADHESIVE THREAD

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BONDING OF FABRIC WITH ADHESIVE THREAD
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2 Claims

ABSTRACT OF THE DISCLOSURE

A fabric having interwoven or integrated adhesive thread therein for bonding to another article or fabric section and a method of producing articles with said fabric are disclosed. The fabric and method are especially useful in closing the open toe in hosiery manufacture.

This invention relates to the bonding of fabric sections and more specifically to the interconnection of fabric sections by adhesive bonding to desired objects as in the fabrication of garments and the like.

A specific application of our invention is in the manufacture of hosiery. Hosiery is conventionally made on automatic knitting machines which form continuous knitted tubes. Each tube comprises a series of interconnected hose with an opening in the toe portion of each hose which enables the continuation of the tube between the succeeding hose. To complete the hose, they are separated from the continuous tube and then, in a semi-manual operation, the open toe portion of the hose is closed. The hose are then dyed and shaped and made ready for shipping.

There are millions of pairs of hose consumed every year, and there are hundreds of manufacturers producing them. Yet, with little variation, the above general method of manufacturing hose is used throughout. The knitting machines that have been developed for this operation are highly sophisticated. They are capable of very rapidly producing the successive hose while automatically changing into the various patterns and readily switching between the numerous types of thread required, as for example, to introduce elastic type ribbing into the leg portion of the hose, etc. As far as we are aware, however, the industry has been unable to develop a mechanism that will affect an automatic closure of the toe opening.

Accordingly, the bottleneck in this fabrication process for many years has been the necessary semi-manual operation employed for closing the toe portions after the hose are separated from the continuous tube. Whereas a knitting machine can rapidly produce many semi-completed hose automatically over a short period of time, to keep up with the production of the single machine, many highly trained workers are employed for closing the toe openings. For each hose, a worker must superimpose two halves of the peripheral edge of the opening, e.g. in the manner of a folding operation, he must align the stitches of each half and carefully position the aligned stitches onto the holding needles of a specially designed sewing wheel. The wheel carries the hose through a looping type sewing station which cooperates with the appropriately spaced needles to sew the aligned stitches together. The

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resulting seam, in almost all hose, including hose for men, women and children (one exception being women's sheer stockings) appears on the top, front portion of the foot and is referred to in the industry as a looper line.

It will be seen that the interruption of the otherwise completely automatic production of hosiery, i.e. the manual operation of folding the edge, aligning the stitches and positioning them over the needles of a sewing wheel, while forming only a small part of the actual production process, is highly costly to the manufacture of hose. It is also very tedious work and is a deterrent to further developments in the other operations of the hose manufacturing process. This situation has existed for many years, and accordingly, there has been an increasing need for improvement in the operation of closing the toe opening.

The procedure for carefully aligning the two halves of the peripheral edge of the opening is required in order to achieve proper register of the stitches necessary for the subsequent looping sewing operation. Accordingly, it is an object of this invention to obviate by novel means and methods the tedious alignment of stitches by replacing the looping sewing operation with adhesive bonding. We are aware that others have directed themselves to this problem as evidenced by U.S. Patent No. 2,493,830 issued to Leon J. Picard on Jan. 10, 1950. (Also see British Patent No. 1,002,931.) In the processes described in these references, the edge of the opening is folded, and a thermoplastic bonding agent is coated over the folded edge. The three layer composite, i.e. the two halves of the edge and the layer of bonding material, is heated to cause the bonding agent to flow between and adhere to the folded edge portions. Although manual folding is maintained, the tedious and time consuming process of aligning the stitches is obviated.

However, a number of undesirable results are experienced by this method of bonding the toe opening. The operation requires the additional manual operation of applying the bonding agent which must be accurately superimposed over the aligned edges. Furthermore, there is no assurance of applying the adhesive in a consistent pattern to the successive hose, resulting in excessive or insufficient amounts of the bonding agent which will cause inadequate closure. Also, the bonding agent fills the interstices of the knitted weave and notably affects the flexibility of the material, thus giving that portion of the hose a different feel, e.g. stiffer, etc. (referred to in the industry as "hand"). This difference in "hand" is objectionable to the consumer.

The present invention avoids these undesirable features while accomplishing the aims and objectives stated above. Thus, one form of the invention, in general, is comprised of an adhesive thread that is introduced into the tubular knitting operation at the point in the tube which forms the toe opening for the successive hose. The hose are thus separated from the tube, and the edges of the toe openings are merely folded together and heat sealed. The amount of adhesive applied in the closing operation is controlled by setting the knitting machine to introduce only a prescribed amount of the thread into each hose. Such adhesive application is thus consistent and provides for a very exacting control in applying only the necessary amount of adhesive. Also, it is believed

that with the adhesive thread replacing the conventional threads, the increase in mass to that portion of the stocking is minimized, and the change in the natural "weave" of the material is minimized. Accordingly, there is a minimum of change in the "hand" or in the dye receiving properties of the material.

The invention will be further understood by referring to the following detailed description and drawings wherein:

FIGURE 1 schematically illustrates a knitted tube as formed on conventional hose manufacturing apparatus;

FIGURE 2 is an enlarged view of an uncompleted hose after it is separated from the knitted tube and prior to the toe closing operation; and

FIGURE 3 illustrates a completed hose having the toe opening closed.

In a tubular hose-knitting operation for producing a continuous knitted tube 10 of interconnected hose segments 12, adhesive thread 14 is knitted into the tube 10 adjacent to the interconnection, i.e. adjacent to the looper line. This is preferably accomplished by a proper programming of the tube knitting apparatus whereby the adhesive thread merely replaces the threads commonly knitted into the tube at said point of interconnection. The individual hose segments 12 are then separated, and the edges 16 of the toe openings are folded together (i.e. on the center line X—X of FIG. 2 and in the manner illustrated by the dotted lines). The folded edge is then subjected to a heat sealing operation which softens the adhesive of the thread 14 and seals the folded edge portions together. In the conventional manner, the hose is then dyed and shaped.

As mentioned above, the apparatus presently in use for knitting the tubes from which hose are produced are designed to automatically introduce into the knitting operation, at selective points in the tube, different threads, as for example, to form patterns in the hose, or to insert elastic thread at different points, etc. The adhesive thread of the present invention can likewise be introduced into the knitting operation and selectively positioned at the edge of the toe openings. A skilled operator of the knitting apparatus need merely to position the thread within a feeding station of the apparatus and properly program the automatic feed control for that station.

Also, the apparatus can introduce the threads into the tube in a manner whereby a segment of the tube is formed entirely of the adhesive thread, or it can be interspersed, as desired, with conventional hose forming threads. The adhesive threads contemplated herein may either be constructed entirely of the desired adhesive material, or it can be comprised of an adhesive material coated over a conventional thread, e.g. adhesive coated nylon.

The preferred adhesive thread is both non-toxic and elastic. It is dyeable while not being adversely affected by the acids or alkali commonly used in fabric dyes, it is dry-cleanable, resistant to body oils, and steam resistant (to withstand the shaping operation commonly referred to in the trade as "boarding"). Upon sealing, the thread should be sufficiently flexible, in addition to having the properties of elasticity, to further simulate the "hand" of the all-fabric portion of the hose.

Adhesive materials which will provide these desired features are generally of the class having thermoplastic properties. A thermoplastic adhesive material having the above properties, and which can be extruded to form adhesive threads, is a urethane type adhesive material. More specifically, a preferred urethane material is a thermoplastic polymeric, ester-type urethane being the reaction product of 4,4-diphenylmethane diisocyanate, adipic acid, and 1,4-butanediol.

The above preferred adhesive material has been suc-

cessfully used in the production of hose as illustrated by the following examples:

Example 1

An extruder with $\frac{1}{2}$ inch inside diameter barrel, 12 inches long, is set up with a No. 1 Zenith metering pump, adapter and 1 inch pot. All components are electrically heated and equipped with thermocouples and temperature recorder. The above preferred adhesive material is placed in the extruder and heated to above its softening point. It is then extruded through a 0.063 inch monofil die, and drawn down through an anti-blocking quench medium consisting of a slurry of soapstone in water containing a small amount of wetting agent (Triton X-100 available from Union Carbide Co.). The all-adhesive thread thus produced is referred to as a monofilament.

The monofilament speed is controlled by a set of Godit rollers. From the Godit rollers, the filament is packaged on a core using a Leeson winder. The size of the monofilament is determined by controlling the feed rate of the adhesive material into the extruder and by controlling the speed of the Godit rolls. In this manner, various sized monofilaments from 0.003 inch diameter to 0.015 inch diameter have been made. When it is desired to reduce elongation, the filaments are hot stretched, e.g. about 50%, over a platen electrically heated to 240° F.

The adhesive thread is introduced into a tube knitting process as follows:

A tube of interconnected hose segments is knitted in the fashion common to the hose manufacturing industry on a circular knitting machine such as a Komet knitter. The body, heel, foot and toe portions are knit to any size and style desired. When the area of the hose segment adjacent to the toe opening is reached (commonly referred to as the looper line), the adhesive thread is substituted for the yarn used in knitting the remainder of the tube. This substitution of adhesive thread is accomplished by appropriately programming the machine knitting cycle in the known manner. Several courses (i.e. in the range of about 2 to 20 courses depending on the type of hose) are knit into the hose.

Subsequent to the introduction of the adhesive thread, several courses of the conventional nylon or cotton thread are knitted into the hose. This completes the cycle and the knitting apparatus then commences to repeat the cycle and thereby knit the next successive hose.

The individual hose segments are separated from the tube and the opening at the toe end is closed. This toe closing operation may be accomplished in a number of ways. Preferably, such closing is accomplished by gripping the edge of the toe opening at opposed points on each side, i.e. see FIG. 2, wherein such points are indicated as the intersection of the imaginary center line X—X with the edge of the opening. The edge is pulled outwardly so that the upper and lower portions of the peripheral edge are brought together as illustrated in dotted lines in said FIG. 2. The looper lines of the upper and lower edge portions are thus in superimposed relationship. The edge portion is placed in a heat sealing machine where heat and pressure are applied to the superimposed looper lines of the edge portion for a period of 5 to 20 seconds at a temperature of about 250° F. to 400° F. and pressure of about 100 to 1000 p.s.i. Subsequent to this bonding operation, the excess material is trimmed off to leave an adhesively bonded seam approximately $\frac{1}{32}$ inch to $\frac{3}{16}$ inch wide. The hose is then placed on a cylindrical form having a rounded top, the diameter of which is approximately equal to that of the hose. The bonded seam is flattened by heat and pressure applied against the rounded top of the form to provide a smooth surface that is comfortable when in contact with a wearer's foot. The hose is then ready to be dyed, boarded or otherwise finished in a manner which is standard for the given type of hose.

Example 2

A 20% solids solution is prepared by dissolving the above preferred adhesive material in tetrahydrofuran. A yarn made up of 70 denier-34 filament nylon is guided through this solution, then through a stripping die to remove surplus solution, then through a heated chamber to facilitate solvent removal, and then onto a winding device. Running speeds from 3 to 100 feet per minute are used. Temperature in the heated chamber is controlled from 150° F. to 350° F. These coated filaments are then knitted into the hose segments in the manner described for Example 1.

In further examples, threads made from other materials are coated as described above to produce the heat-sealable adhesive thread. Such threads include:

Nylon yarn: 70/34; 20/7; 75/20/1; 35/15/1

Nylon monofilament: 15 denier

Stretch-all nylon: 70/13/1

Superloft nylon: 20/13/1

Seminol natural: 24/4

Cotton thread, mercerized, black: #00; #50; #60

By controlling solution viscosity and running peel speed, the amount of adhesive pick up by the yarn was varied from 38% to 170% by weight of thread.

In still further examples, adhesive materials other than the above preferred adhesive material were used for producing both the monofilaments described under Example 1 and the adhesively-coated threads described under Example 2. Such further adhesive materials include a mixture made up of the above preferred adhesive (95% by wt.) and barium ferrite (5% by wt.). The addition of this latter material and similar materials permits bonding by dielectric energy.

Although we do not wish to be bound by this theory, it is our belief that it is novel to provide adhesive threads which can be interwoven or interspersed with conventional thread materials for providing a means of attachment for a fabric portion of a garment. Therefore, it is not our intention to limit our invention to any specific adhesive thread, or process of making or heat sealing the garment. Thus, for example, in the heat-sealing apparatus for adhesively sealing the fabric portion, various forms of heat can be applied by various types of apparatus and such heat may be generated, as for example, radiantly, ultrasonically, dielectrically or through conduction from a hot platen.

Furthermore, as illustrated by the examples, the adhesive thread can take the form of the monofilament whereby the entire thread is composed of the adhesive material, or it can take the form of a conventional type thread coated with the said adhesive materials. Still further, it may be desired, at the point of the knitting operation wherein the adhesive threads are introduced, to form the entire segment of adhesive threads (monofilaments or adhesively coated threads or a mixture thereof) or said adhesive threads may be interspersed as desired with conventional threads.

It will be understood that in bonding two portions of a garment together, the adhesive thread can be interwoven into one or both portions. Thus, for example, in the hose, adhesive thread may be interspersed with the threads of one half only of the edge of the toe opening, or the adhesive may be applied fully around the edge opening.

It will also be understood that "interwoven" and interspersed, as the terms are used herein, are not limited to a specific pattern or type of weaving. Rather, they are applied to their broadest sense and include all forms of sewing, knitting, hand stitching, etc. wherein the thread is entrapped among other threads to become integrated therewith in forming a fabric section.

It is furthermore understood that other garments than hose are contemplated herein as for example:

(a) The invention can be applied to lace bonding wherein an adhesive monofilament is knitted into the lace in a programmed manner such that said lace may be attached to an article of apparel by heat tacking.

(b) The invention can be used for affixing labels to garments whereby, during the weaving of the garment labels, the adhesive monofilaments are programmed into the label such that it may be heat tacked to an article of apparel.

(c) The invention can be applied to sheet hemming on shuttle-less looms wherein filaments of adhesive thread are substituted for several warp threads at the edges of the sheet during weaving permitting said sheet material to be folded and heat tacked to form a hem and to prevent fraying of the edges.

(d) The invention can be applied to spandex fabric wherein filaments of adhesive thread are integrally knit into the fabric in the desired proportions permitting said spandex fabric to be used in any and all fabrications where either a portion or all of the fabric may require a bonding operation. Said spandex fabric (with adhesive threads) may be die-cut to form control panels for girdles (women's foundation garments) and heat bonded to conventional spandex fabric.

(e) The invention can be used in the production of garters and accessory items wherein elastic and non-elastic garter materials which are conventionally sewn in place may be heat bonded when said materials are of the type that have adhesive threads integrally knit or woven into them. In like manner, accessory items such as waist banding may also be heat bonded in place.

(f) The invention can be used for straps for slips and brassieres wherein cotton, nylon, rayon, etc. materials, made specifically for use as straps for slips and bras are fabricated in such a manner that adhesive threads are integrally woven or knit into them to permit said straps to be heat bonded to the appropriate article of apparel.

(g) The invention can be used for quilting materials wherein introduction of adhesive threads into those materials is used for quilt patterns. Such permits selective bonding of the layers of fabric to form the quilts and offers the advantage (over sewing) of not creating holes in the top layer. These holes usually result in loss of efficiency in insulating ability of the quilted fabric.

(h) The invention can be used in the operation of sewing on buttons wherein an adhesive thread is used to sew on the buttons and then exposed to a heat and pressure operation. The threads are fused to each other and to the fabric and results in elimination of loose ends of thread that can cause unravelling and loss of buttons.

(i) The invention can be used in surging or overcast stitching wherein adhesive coated thread can be substituted for conventional thread in the surge process. The threads can be heat sealed after they have been sewn to insure a sealed edge and avoid fraying in the fabric at seams.

What we claim is:

1. An article having two portions adhesively interconnected along a narrow line, at least one of said portions being composed of a fabric, a thermoplastic adhesive thread selected from the group consisting of an adhesive coated fabric filament and a monofilament of extruded polymeric ester-type urthane adhesive interspersed with the conventional threads of said at least one fabric portion, said interspersed adhesive thread of said one portion being in direct contact with the other portion, the adhesive being heat softened to securely bond the portions together.

2. An article according to claim 1 characterized in being hose, the toe portion of said hose having a looper line, said looper line having a thermoplastic adhesive thread interspersed with the conventional threads of the hose fabric, said interspersed adhesive thread of said looper line being heat softened to securely heat bond the two portions of said looper line together.

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